

BCA Benefits and Assumptions Summary

The Plymouth Multimodal Center generates a variety of benefits, ranging from monetary such as increased transit fare revenue, to social such as reduced emissions. Accounting for various costs that are realized over a 20-year period involves making assumptions based on current available data and anticipated trends over time. The bulk of the calculation of benefits in the BCA is based on the assumed growth of GATRA ridership due to the improved Plymouth Multimodal Center, and the four new routes made possible through the Project. As a result of the Project, existing GATRA routes will become more attractive to riders, increasing ridership on existing routes. The combination of net new riders to existing routes, and riders of new routes, serves as a base for calculating the following benefits:

- Transit revenue
- Travel time savings
- Tourism spending
- Reduced Emissions – Net Non CO2
- Reduced Emissions – Social Cost of Carbon
- Auto operating cost savings

The increase in transit riders on each route were developed based on annual transit riders on the four existing routes, with data provided by GATRA. The new ridership for the three proposed routes is based on daily one-way person trips and operating days per year, with data also provided by GATRA and the Southeastern Regional Planning and Economic Development District (SRPEDD) - the regional planning agency serving GATRA. The annual ridership for each existing route was grown at 5% per year for a no build scenario. For a build scenario ridership was grown by 10% for the first two years after the completion of construction in 2019, and 5% thereafter.

Operating costs and revenues associated with the Project were developed by Project partners in consultation with MassDevelopment, and are included in the BCA. Assumptions regarding parking revenue, operating costs, and other factors are preliminary and will be refined as the Project progresses, but are appropriate for the 30 percent design level. Assumptions and sources for the benefits are provided below.

Criteria	Benefit(s)	Inputs	Assumptions
State of Good Repair	Value of Land <i>The town of Plymouth is donating the land for the project site</i>	<ul style="list-style-type: none"> Existing lot value of Memorial Drive Parking lot Value of property upon project completion Net annual increase in property 	<ul style="list-style-type: none"> \$650,000 value of Memorial Drive parking lot based on 2012 Site Selection Study, Appendix J – Financial Feasibility, plus appreciation of 3% per year from 2011 when estimate was made, to 2015 when Project cost estimate was established. This cost is addressed as an in-kind donation by the Town of Plymouth as a Project Partner Multiplier of four used for improved value of property, based on Franklin Regional Transit Center, Greenfield, MA case study. Property value appreciation at 3%/year. Net increase included as a benefit
	Value of Rent Savings for bus area <i>GATRA will not pay rent for the 600 SF passenger waiting area</i>	<ul style="list-style-type: none"> Value of GATRA Lease Annual rent increase 	<ul style="list-style-type: none"> 600 SF passenger waiting area Value of rent saved is estimated to be \$20/SF, or \$12,000 in the first year (MassDevelopment Proforma for commercial space) Annual rent increase of 3%/year
	Transit Revenue <i>Growth in riders will generate additional farebox revenue</i>	<ul style="list-style-type: none"> Assumed fare box revenue in 2019 Net new transit riders for existing routes and new transit riders on new routes 	<ul style="list-style-type: none"> 2014 GATRA fare is \$1.00 and fare is assumed to be \$1.25 at project completion in 2019 Fare increase of 5% every 5 years Fare structure provided by GATRA
	Parking Revenue <i>Additional parking will increase revenue</i>	<ul style="list-style-type: none"> Gross revenues from parking garage and new Court Street area meters Annual increase in revenue 	<ul style="list-style-type: none"> Gross parking revenues based on PGCD and Mass Development Operating Proforma Total revenue of \$712,300 in first year Annual increase of 3%/year
Economic Competitiveness	Travel time savings 1. <i>Increased route efficiency saves passenger time due to ease of transfer</i>	<ul style="list-style-type: none"> Value of travel time savings Net new riders on existing routes and new riders on proposed routes 	<ul style="list-style-type: none"> Travel time savings determined based on the amount of time saved by riding a bus vs. walking a route, based on average driving and walking speeds.

	<p>2. <i>New routes provide people with the choice of riding transit over walking, which will reduce their travel time, particularly between the waterfront and uphill locations on Court Street.</i></p>		<ul style="list-style-type: none"> • Assumed one mile (.3 hours) is saved by using the seasonal circulator • Assumed 10 minutes (.17 hours) saved for riders on existing routes • Value of travel time based on TIGER BCA Resource Guide at \$13.00 per hour for all local travel purposes
	<p>Tourism spending from new transit service <i>Downtown Plymouth will be made more accessible to people who will spend more money on retail goods and at attractions</i></p>	<ul style="list-style-type: none"> • New transit riders on Seasonal Circulator • Number of visitors to downtown Plymouth • Amount of time spent in downtown Plymouth • Retail expenditures and the value of tourism expenditure per site • Increase per year in spending 	<ul style="list-style-type: none"> • The Seasonal Circulator route is expected to increase tourism spending. Other routes may also increase tourism spending, but are not included in the BCA due to qualitative benefits. • Assumed 6,667 daily visitors to downtown Plymouth based on 1,000,000 visitors to downtown attractions per year and a tourist season of five months, or 150 days (Plymouth 400) • Assumed three hour stay in downtown Plymouth (based on Plymouth Convention Center and Visitor's Bureau's (PCCV) data) of four-hour average stays in Plymouth. The four hours may include sites away from downtown, such as Plymouth Plantation, so a three hour stay downtown was assumed for this calculation. • Assumed 30% of visitors arrive by bus, based on estimates by PCCV. These visitors are dependent on local transit provided by GATRA, pedestrian and bicycle amenities provided by the Project. • Expenditures based on a \$6.00 average price of adult admission to 6 main attractions and average expenditure of \$25.00 at retail locations, based on Plymouth 400 estimates. • 3% increase in spending per year
Quality of Life/ Environmental Sustainability	<p>Reduced emissions – Net Non Co2 from new transit routes</p>	<ul style="list-style-type: none"> • Total Emissions Value of VOC Savings • Total Emissions Value of NOx Savings 	<ul style="list-style-type: none"> • Summer reduction of VOC and NOx per year in kg, estimated based on daily person trips by route (from Southeastern Regional Planning and Economic Development District (SRPEDD))

	<i>Improved air quality is a social benefit and will enhance quality of life for residents and tourists</i>		extrapolated for 20 years and SRPEDD CMAQ New Bus Service Air Quality Analysis worksheet developed in 2015 <ul style="list-style-type: none"> VOC and NOx value per short ton, based on TIGER BCA resource guide (3/27/15) for all local travel purposes.
	Reduced emissions – Net Non Co2 from additional riders on existing routes <i>Improved air quality is a social benefit and will enhance quality of life for residents and tourists</i>	<ul style="list-style-type: none"> Total Emissions Value of VOC Savings Total Emissions Value of NOx Savings 	<ul style="list-style-type: none"> Summer reduction of VOC and NOx per year in kg, estimated based on net new daily person trips by route (estimated from annual net new riders) and SRPEDD CMAQ New Bus Service Air Quality Analysis worksheet, modified to not include bus emissions, as existing routes are already running VOC and NOx value per short ton, based on TIGER BCA resource guide (3/27/15) for all local travel purposes.
	Reduced emissions – Social cost of carbon from new routes <i>Improved air quality is a social benefit and will enhance quality of life for residents and tourists</i>	<ul style="list-style-type: none"> Total Emissions value of winter CO2 and Summer CO2 Social cost of carbon discount rate 	<ul style="list-style-type: none"> Winter and summer reductions of CO2 per year in kg, estimated based on daily person trips by route (from SRPEDD) extrapolated for 20 years and SRPEDD CMAQ New Bus Service Air Quality Analysis worksheet Conversion factor of 1000 kg/metric ton, based on TIGER BCA resource guide (3/27/15) for all local travel purposes. Social cost of carbon discount rate of 3% per year in 2013 dollars, based on TIGER BCA resource guide (3/27/15)
	Reduced emissions – Social cost of carbon from additional riders on existing routes <i>Improved air quality is a social benefit and will enhance quality of life for residents and tourists</i>	<ul style="list-style-type: none"> Total Emissions value of winter CO2 and Summer CO2 Social cost of carbon discount rate 	<ul style="list-style-type: none"> Winter and summer reductions of CO2 per year in kg, estimated based on net new daily person trips by route (estimated from annual net new riders) and SRPEDD CMAQ New Bus Service Air Quality Analysis worksheet, modified to not include bus emissions, as existing routes are already running on TIGER BCA resource guide (3/27/15) for all local travel purposes. Social cost of carbon discount rate of 3% per year in 2013 dollars, based on TIGER BCA resource guide (3/27/15)

Economic Competitiveness	<p>Job creation <i>A new multimodal center will increase GATRA service and number of the employment opportunities directly related to the transit center</i> <i>Additional job creation will likely create secondary benefits not included in BCA</i></p>	<ul style="list-style-type: none"> • Number of new jobs created for GATRA Service • GATRA Annual salary • Annual wage increase 	<ul style="list-style-type: none"> • Assumed new routes add seven new drivers. • Annual salary of \$36,354.24 based on GATRA hourly rate of \$19.42 and 36 hours per week, 52 weeks a year • Annual wage increase of 2.5%
	<p>Commercial space revenue <i>Increased commercial space will lead to an increase in rental revenue</i></p>	<ul style="list-style-type: none"> • Effective Gross Revenues from commercial operations • Rent growth per year 	<ul style="list-style-type: none"> • Rental Revenues and Operating expense assumptions from PGDC and Mass Development Commercial Operating Proforma, starting at \$84,900 in year one • Rent growth per year of 3%
	<p>Auto operating cost savings <i>An increase in transit trips also results in a decrease in auto trips for those trips that are assumed to be diverted from cars to transit. This results in a reduced cost for auto operations.</i></p>	<ul style="list-style-type: none"> • Vehicle occupancy for standard and seasonal/tourist trips • Percentage of transit riders diverted from vehicles on existing routes and new routes • Net new diverted auto trips derived from net new riders on existing routes, and newly diverted auto trips derived from new riders on proposed routes • VMT of net new diverted auto trips • Vehicle operating costs 	<ul style="list-style-type: none"> • Assumed vehicle occupancy of 1.06 for standard trips (SRPEDD) • Assumed vehicle occupancy of 3.0 for seasonal/tourist routes in Plymouth (Plymouth Transportation Center Site Selection Study) • 100% of transit riders diverted from vehicles on two new year-round routes (SRPEDD) • 25% of transit riders diverted from vehicles on existing routes and new Seasonal Circulator route, as new riders are less likely to all shift from driving • Assumed diverted VMT is 50% of existing routes and 100% of new routes • Assumed vehicle operating costs of \$0.592 per mile, based on American Automobile Association 2014 "Your Driving Costs" for average sedan driven 15,000 miles per year • Assumed 3% increase per year in operating costs

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Plymouth Multimodal Center
Benefit Cost Analysis
2016 TIGER

Benefit Cost Analysis					Initiate Construction		Construction Complete											
2016 TIGER																		
			Year (20 year forecast)	TOTALS	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	
TIGER Benefit Category			Benefits															
State of Good Repair			Value of land for project site				\$650,000	\$ 1,950,000.00	\$ 78,000.00	\$ 80,340.00	\$ 82,750.20	\$ 85,232.71	\$ 87,789.69	\$ 90,423.38	\$ 93,136.08	\$ 95,930.16	\$ 98,808.07	
State of Good Repair			Value of rent savings for bus area	\$	-	\$ -		\$ 12,000.00	\$ 12,360.00	\$ 12,730.80	\$ 13,112.72	\$ 13,506.11	\$ 13,911.29	\$ 14,328.63	\$ 14,758.49	\$ 15,201.24	\$ 15,657.28	
State of Good Repair			Transit Revenue (fare box)	\$	-	\$ -	\$ -	\$ 219,249.47	\$ 250,755.12	\$ 263,292.87	\$ 276,457.52	\$ 304,794.41	\$ 320,034.13	\$ 336,035.84	\$ 352,837.63	\$ 370,479.51	\$ 407,527.46	
State of Good Repair			Parking revenue				\$	\$ 712,300.00	\$ 733,669.00	\$ 755,679.07	\$ 778,349.44	\$ 801,699.93	\$ 825,750.92	\$ 850,523.45	\$ 876,039.15	\$ 902,320.33	\$ 929,389.94	
Economic Competitiveness			Travel time savings (passengers)	\$	-	\$ -	\$ -	\$ 489,502.11	\$ 538,452.32	\$ 565,374.94	\$ 593,643.68	\$ 623,325.87	\$ 654,492.16	\$ 687,216.77	\$ 721,577.61	\$ 757,656.49	\$ 795,539.31	
Economic Competitiveness			Tourism spending from new transit service	\$	-	\$ -	\$ -	\$ 1,476,533.33	\$ 1,672,912.27	\$ 1,809,254.62	\$ 1,956,708.87	\$ 2,116,180.64	\$ 2,288,649.36	\$ 2,475,174.29	\$ 2,676,900.99	\$ 2,895,068.42	\$ 3,131,016.50	
Quality of Life/Environmental Sustainability			Reduced emissions - Net Non Co2				\$	\$ 776.26	\$ 896.92	\$ 963.60	\$ 1,032.58	\$ 1,106.01	\$ 1,184.22	\$ 1,265.15	\$ 1,348.58	\$ 1,437.00	\$ 1,531.27	
Quality of Life/Environmental Sustainability			Reduced emissions - Social Cost of Carbon				\$	\$ 6,699.11	\$ 7,865.24	\$ 8,437.10	\$ 9,375.87	\$ 10,215.27	\$ 11,123.46	\$ 12,082.88	\$ 13,092.99	\$ 14,419.16	\$ 15,607.68	
Quality of Life/Environmental Sustainability			Existing Routes Reduced emissions - Net Non Co2				\$	\$ 83.90	\$ 180.63	\$ 189.71	\$ 198.78	\$ 208.94	\$ 219.62	\$ 230.56	\$ 242.07	\$ 254.34	\$ 266.92	
Quality of Life/Environmental Sustainability			Existing Routes Reduced emissions - Social Cost of Carbon				\$	\$ 706.81	\$ 1,551.52	\$ 1,629.51	\$ 1,773.17	\$ 1,898.25	\$ 2,031.56	\$ 2,170.89	\$ 2,319.23	\$ 2,520.76	\$ 2,689.55	
Economic Competitiveness			Job creation				\$	\$ 287,920.40	\$ 295,118.41	\$ 302,496.37	\$ 310,058.78	\$ 317,810.25	\$ 325,755.51	\$ 333,899.39	\$ 342,246.88	\$ 350,803.05	\$ 359,573.13	
Economic Competitiveness			Commercial space revenue				\$	\$ 84,899.65	\$ 87,446.64	\$ 90,070.04	\$ 92,772.14	\$ 95,555.30	\$ 98,421.96	\$ 101,374.62	\$ 104,415.86	\$ 107,548.34	\$ 110,774.79	
Economic Competitiveness			Auto operating cost savings	\$	-	\$ -	\$	\$ 474,666.29	\$ 544,476.80	\$ 588,851.66	\$ 636,843.07	\$ 688,745.79	\$ 744,878.57	\$ 805,586.17	\$ 871,241.44	\$ 942,247.62	\$ 1,019,040.80	
Total Benefit (monetized)				\$154,981,949	\$0	\$0	\$650,000	\$5,715,337	\$4,223,685	\$4,479,310	\$4,753,077	\$5,060,279	\$5,374,242	\$5,710,312	\$6,070,157	\$6,455,886	\$6,887,423	
Discounted Benefit 3%				\$100,048,238	\$0	\$0	\$594,842	\$5,078,003	\$3,643,388	\$3,751,352	\$3,864,686	\$3,994,631	\$4,118,909	\$4,249,008	\$4,385,211	\$4,528,029	\$4,690,000	
Discounted Benefit 7%				\$59,421,371	\$0	\$0	\$530,594	\$4,360,203	\$3,011,429	\$2,984,754	\$2,959,977	\$2,945,129	\$2,923,232	\$2,902,833	\$2,883,888	\$2,866,491	\$2,858,036	
Year					0	1	2	3	4	5	6	7	8	9	10	11	12	

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		Year (20 year forecast)	TOTALS	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
TIGER Benefit Category		Benefits											
State of Good Repair		Value of land for project site		\$ 101,772.31	\$ 104,825.48	\$ 107,970.24	\$ 111,209.35	\$ 114,545.63	\$ 117,982.00	\$ 121,521.46	\$ 125,167.10	\$ 128,922.12	\$ 132,789.78
State of Good Repair		Value of rent savings for bus area		\$ 16,127.00	\$ 16,610.81	\$ 17,109.13	\$ 17,622.40	\$ 18,151.08	\$ 18,695.61	\$ 19,256.48	\$ 19,834.17	\$ 20,429.20	\$ 21,042.07
State of Good Repair		Transit Revenue (fare box)		\$ 427,903.84	\$ 449,299.03	\$ 471,763.98	\$ 495,352.18	\$ 543,761.60	\$ 570,949.67	\$ 599,497.16	\$ 629,472.02	\$ 660,945.62	\$ 693,992.90
State of Good Repair		Parking revenue		\$ 957,271.64	\$ 985,989.79	\$ 1,015,569.48	\$ 1,046,036.56	\$ 1,077,417.66	\$ 1,109,740.19	\$ 1,143,032.40	\$ 1,177,323.37	\$ 1,212,643.07	\$ 1,249,022.36
Economic Competitiveness		Travel time savings (passengers)		\$ 835,316.28	\$ 877,082.09	\$ 920,936.20	\$ 966,983.01	\$ 1,015,332.16	\$ 1,066,098.77	\$ 1,119,403.71	\$ 1,175,373.89	\$ 1,234,142.58	\$ 1,295,849.71
Economic Competitiveness		Tourism spending from new transit service		\$ 3,386,194.34	\$ 3,662,169.18	\$ 3,960,635.97	\$ 4,283,427.80	\$ 4,632,527.17	\$ 5,010,078.13	\$ 5,418,399.50	\$ 5,859,999.06	\$ 6,337,588.98	\$ 6,854,102.48
Quality of Life/Environmental Sustainability		Reduced emissions - Net Non Co2		\$ 1,629.31	\$ 1,732.51	\$ 1,839.05	\$ 1,952.16	\$ 2,072.01	\$ 2,198.46	\$ 2,328.54	\$ 2,465.60	\$ 2,610.84	\$ 2,764.34
Quality of Life/Environmental Sustainability		Reduced emissions - Social Cost of Carbon		\$ 16,866.26	\$ 18,210.38	\$ 19,317.21	\$ 21,142.97	\$ 22,772.67	\$ 24,514.97	\$ 26,339.70	\$ 28,286.43	\$ 30,806.78	\$ 33,063.40
Quality of Life/Environmental Sustainability		Existing Routes Reduced emissions - Net Non Co2		\$ 280.26	\$ 294.16	\$ 308.85	\$ 324.62	\$ 340.63	\$ 88.77	\$ 373.09	\$ 394.07	\$ 413.58	\$ 434.68
Quality of Life/Environmental Sustainability		Existing Routes Reduced emissions - Social Cost of Carbon		\$ 2,870.24	\$ 3,061.20	\$ 3,214.10	\$ 3,485.42	\$ 3,713.61	\$ 3,956.25	\$ 4,190.80	\$ 4,491.51	\$ 4,850.56	\$ 5,169.81
Economic Competitiveness		Job creation		\$ 368,562.45	\$ 377,776.52	\$ 387,220.93	\$ 396,901.45	\$ 406,823.99	\$ 416,994.59	\$ 427,419.45	\$ 438,104.94	\$ 449,057.56	\$ 460,284.00
Economic Competitiveness		Commercial space revenue		\$ 114,098.03	\$ 117,520.97	\$ 121,046.60	\$ 124,678.00	\$ 128,418.34	\$ 132,270.89	\$ 136,239.02	\$ 140,326.19	\$ 144,535.97	\$ 148,872.05
Economic Competitiveness		Auto operating cost savings		\$ 1,102,092.63	\$ 1,191,913.18	\$ 1,289,054.10	\$ 1,394,112.01	\$ 1,507,732.14	\$ 1,630,612.31	\$ 1,763,507.21	\$ 1,907,233.05	\$ 2,062,672.54	\$ 2,230,780.35
Total Benefit (monetized)			\$154,981,949	\$7,330,985	\$7,806,485	\$8,315,986	\$8,863,228	\$9,473,609	\$10,104,181	\$10,781,509	\$11,508,471	\$12,289,619	\$13,128,168
Discounted Benefit	3%		\$100,048,238	\$4,846,644	\$5,010,686	\$5,182,247	\$5,362,399	\$5,564,747	\$5,762,273	\$5,969,460	\$6,186,370	\$6,413,860	\$6,851,492
Discounted Benefit	7%		\$59,421,371	\$2,843,082	\$2,829,430	\$2,816,912	\$2,805,871	\$2,802,899	\$2,793,890	\$2,786,147	\$2,779,446	\$2,773,929	\$2,963,200
Year				13	14	15	16	17	18	19	20	21	22

Costs												
Transit service operating costs	split over three years	\$ 1,030,473.94	\$ 1,061,388.16	\$ 1,093,229.81	\$ 1,126,026.70	\$ 1,159,807.50	\$ 1,194,601.73	\$ 1,230,439.78	\$ 1,267,352.97	\$ 1,305,373.56	\$ 3,695,527.47	
Transportation Center operating costs		\$ 494,614.45	\$ 509,452.88	\$ 524,736.47	\$ 540,478.56	\$ 556,692.92	\$ 573,393.70	\$ 590,595.52	\$ 608,313.38	\$ 626,562.78	\$ 645,359.67	
Commercial space operating costs		\$18,004.45	\$18,454.56	\$18,915.93	\$19,388.83	\$19,873.55	\$20,370.39	\$20,879.65	\$21,401.64	\$21,936.68	\$22,485.09	
Construction Costs												
Construction Costs (financing)	split over 2 years	\$ 236,653.33	\$ 236,653.33	\$ 236,653.33	\$ 236,653.33	\$ 236,653.33	\$ 236,653.33	\$ 236,653.33	\$ 236,653.33	\$ 236,653.33	\$ 236,653.33	
Soft Costs (design, permitting)												
Land acquisition												
Rolling stock												
	\$ 62,772,137	\$ 1,779,746.18	\$ 1,825,948.94	\$ 1,873,535.54	\$ 1,922,547.42	\$ 1,973,027.30	\$ 2,025,019.15	\$ 2,078,568.28	\$ 2,133,721.33	\$ 2,190,526.36	\$ 4,600,025.56	
	\$ 49,532,804.80	\$ 1,176,621.89	\$ 1,172,007.14	\$ 1,167,525.41	\$ 1,163,172.81	\$ 1,158,945.60	\$ 1,154,840.13	\$ 1,150,852.86	\$ 1,146,980.35	\$ 1,143,219.28	\$ 2,330,794.99	
	\$38,344,639	\$ 690,216.25	\$ 661,807.93	\$ 634,631.31	\$ 608,629.28	\$ 583,747.58	\$ 559,934.67	\$ 537,141.54	\$ 515,321.62	\$ 494,430.64	\$ 970,361.06	
		13	14	15	16	17	18	19	20	21	22	

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1-transit riders

Plymouth Multimodal Center
Annual Transit Riders

				Initiate Construction		Construction Complete		Consistent growth 5%							
2015		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	
Existing Routes		Growth No-Build													
	Manomet/Cedarville	10,393		10393	10913	11,458	12,031	12,633	13,264	13,928	14,624	15,355	16,123	16,929	17,776
	Freedom	34,746		34746	36483	38,307	40,223	42,234	44,346	46,563	48,891	51,336	53,902	56,598	59,427
	Mayflower	37,393		37393	39263	41,226	43,287	45,451	47,724	50,110	52,616	55,246	58,009	60,909	63,955
	Liberty	43,581		43581	45760	48,048	50,450	52,973	55,622	58,403	61,323	64,389	67,608	70,989	74,538
	Subtotal:		126113	132419	139,040	145,992	153,291	160,956		169,003	177,454	186,326	195,643	205,425	215,696
Existing Routes		Growth Transit Center - first two years													
	Manomet/Cedarville	10393						13,234	14,558	15,286	16,050	16,852	17,695	18,580	19,509
	Freedom	34746						44,245	48,670	51,103	53,658	56,341	59,158	62,116	65,222
	Mayflower	37393						47,616	52,377	54,996	57,746	60,633	63,665	66,848	70,191
	Liberty	43581						55,496	61,045	64,097	67,302	70,667	74,201	77,911	81,806
	Subtotal:		-	-	-	-	-	328,691	361,560	379,638	398,620	418,551	439,478	461,452	484,525
Proposed Routes															
West Plymouth	(Route 3)							45,900	50,490	53,015	55,665	58,448	61,371	64,439	67,661
Inter-City connector	(Route 1)							83,000	91,300	95,865	100,658	105,691	110,976	116,525	122,351
Seasonal Connector	(Route 2)							39,200	43,120	45,276	47,540	49,917	52,413	55,033	57,785
Subtotal:			-	-	-	-	-	328,691	361,560	379,638	398,620	418,551	439,478	461,452	484,525
Additional riders for Build							(145,992)	175,400	200,604	210,634	221,166	232,224	243,836	256,027	268,829

Notes

5% Growth in transit for No Build is based on historical data for GATRA Plymouth Area Link (PAL) service. Projections included in 2010 Site Selection Study, from 2008 CSA for PAL restructuring of routes

10% Growth in transit assumes higher usage of transit for first 2 years with improved facilities and multi-modal connections provided by the project

Proposed Routes - developed by GATRA and SRPEDD				(see SRPEDD sheets 10, 11, 12)	
		West Plymouth	Inter-City connector	Seasonal Connector	
Year-Round		(Route 3)	(Route 1)	(Route 2)	
Days of service per week		6			
Hours per day		12			
# roundtrips		12			
Days per year		306			
Daily one-way person trips		150			
Summer					
Days of service per week			7		7
Hours per day			13		16
# roundtrips			26		32
Days per year			112		112
Daily one-way person trips			250		350
Winter					
Days of service per week			6		
Hours per day			10		
# roundtrips			20		
Days per year			220		
Daily one-way person trips			250		
Annual ridership		45900	83000	39200	

1-transit riders

Plymouth Multimodal Center
Annual Transit Riders

2015		2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Existing Routes		Growth No-Build											
		5%											
	Manomet/Cedarville	10,393	18,664	19,598	20,577	21,606	22,687	23,821	25,012	26,263	27,576	28,955	30,402
	Freedom	34,746	62,399	65,519	68,795	72,234	75,846	79,638	83,620	87,801	92,191	96,801	101,641
	Mayflower	37,393	67,152	70,510	74,036	77,737	81,624	85,705	89,991	94,490	99,215	104,175	109,384
	Liberty	43,581	78,265	82,178	86,287	90,602	95,132	99,888	104,883	110,127	115,633	121,415	127,486
Subtotal:			226,481	237,805	249,695	262,180	275,289	289,053	303,506	318,681	334,615	351,346	368,913
Existing Routes		Growth Transit Center - first two years											
		10%											
	Manomet/Cedarville	10393	20,484	21,508	22,584	23,713	24,899	26,144	27,451	28,823	30,265	31,778	33,367
	Freedom	34746	68,483	71,907	75,503	79,278	83,242	87,404	91,774	96,363	101,181	106,240	111,552
	Mayflower	37393	73,700	77,385	81,254	85,317	89,583	94,062	98,765	103,704	108,889	114,333	120,050
	Liberty	43581	85,897	90,191	94,701	99,436	104,408	109,628	115,110	120,865	126,908	133,254	139,916
Proposed Routes	West Plymouth	(Route 3)	71,045	74,597	78,327	82,243	86,355	90,673	95,206	99,967	104,965	110,213	115,724
	Inter-City connector	(Route 1)	128,468	134,892	141,636	148,718	156,154	163,962	172,160	180,768	189,806	199,296	209,261
	Seasonal Connector	(Route 2)	60,674	63,708	66,893	70,238	73,750	77,437	81,309	85,375	89,643	94,126	98,832
	Subtotal:		508,751	534,188	560,898	588,943	618,390	649,309	681,775	715,864	751,657	789,240	828,702
Additional riders for Build			282,270	296,384	311,203	326,763	343,101	360,256	378,269	397,182	417,042	437,894	459,788

Notes

5% Growth in transit for No Build is based on historical data for GATRA Plymouth Area Link (PAL) service. Projections included in 2010 Site Selection Study, from 2008 CSA for PAL restructuring of routes

10% Growth in transit assumes higher usage of transit for first 2 years with improved facilities and multi-modal connections provided by the project

2-transit riders_NET NEW

Plymouth Multimodal Center
Annual Net New Transit Riders

						Initiate Construction		Construction Complete		Consistent growth 5%							
		2015	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025			
Existing Routes		Growth															
		10%	Transit Center														
			first 2 years														
	Manomet/Cedar	10,393						602	1,293	1,358	1,426	1,497	1,572	1,651			
	Freedom	34,746						2,011	4,324	4,540	4,767	5,006	5,256	5,519			
	Mayflower	37,393						2,164	4,653	4,886	5,130	5,387	5,656	5,939			
	Liberty	43,581						2,523	5,423	5,695	5,979	6,278	6,592	6,922			
Proposed Routes																	
	West Plymouth (Route 3)							45,900	50,490	53,015	55,665	58,448	61,371	64,439			
	Inter-City connn (Route 1)							83,000	91,300	95,865	100,658	105,691	110,976	116,525			
	Seasonal Conne (Route 2)							39,200	43,120	45,276	47,540	49,917	52,413	55,033			
	Net New Riders		-	-	-	-	-	175,400	200,604	210,634	221,166	232,224	243,836	256,027			

Notes

Existing Routes for 10% growth rate represents net new riders to those routes the first two years, then 5% growth for future years. These calculations serve as the basis for benefits generated by this net increase.

2-transit riders_NET NEW

Plymouth Multimodal Center
Annual Net New Transit Riders

	2015	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Existing Routes	10%													
Manomet/Cedar	10,393	1,733	1,820	1,911	2,006	2,107	2,212	2,323	2,439	2,561	2,689	2,823	2,964	3,113
Freedom	34,746	5,795	6,084	6,388	6,708	7,043	7,395	7,765	8,153	8,561	8,989	9,439	9,911	10,406
Mayflower	37,393	6,236	6,548	6,875	7,219	7,580	7,959	8,357	8,775	9,213	9,674	10,158	10,666	11,199
Liberty	43,581	7,268	7,631	8,013	8,414	8,834	9,276	9,740	10,227	10,738	11,275	11,839	12,431	13,052
Proposed Routes														
West Plymouth (Route 3)		67,661	71,045	74,597	78,327	82,243	86,355	90,673	95,206	99,967	104,965	110,213	115,724	121,510
Inter-City connr (Route 1)		122,351	128,468	134,892	141,636	148,718	156,154	163,962	172,160	180,768	189,806	199,296	209,261	219,724
Seasonal Conne (Route 2)		57,785	60,674	63,708	66,893	70,238	73,750	77,437	81,309	85,375	89,643	94,126	98,832	103,773
<i>Net New Riders</i>		268,829	282,270	296,384	311,203	326,763	343,101	360,256	378,269	397,182	417,042	437,894	459,788	482,778

Notes

Existing Routes for 10% growth rate represents net new ride those routes the first two years, then 5% growth for future y
These calculations serve as the basis for benefits generated I
increase.

3-land.rent

Plymouth Multimodal Center
Land and Transit space benefit

Annual Rental Increase	3%						Initiate Construction		Construction Complete		2020	2021	2022			
				2014	2015	2016	2017	2018	2019							
land value increase	3%	Existing lot	Improved*													
Value of Memorial Drive Parking lot		\$	650,000.00	\$	2,600,000.00		\$	650,000.00	\$	2,600,000.00	\$	2,678,000.00	\$	2,758,340.00	\$	2,841,090.20
Net increase in value							\$	650,000.00	\$	1,950,000.00	\$	78,000.00	\$	80,340.00	\$	82,750.20
Value of GATRA lease									\$12,000	\$12,360	\$12,731	\$13,113				

Notes

Value of Memorial Drive parking lot based on 2012 Site Selection Study, Appendix J - Financial Feasibility, plus appreciation of 3% per year from 2011 when estimate was made, to 2015 when Project cost estimate was established. This cost is addressed as an in-kind donation by the Town of Plymouth as a Project Partner

Multiplier of 4 used for improved value of property based on Franklin Regional Transit Center, Greenfield, MA case study

2009 value of 12 Olive Street	\$	890,000.00
2015 Developed value	\$	3,551,000.00

3.99

GATRA will not pay rent for the 600 SF passenger waiting area. The value of the rent saved is estimated to be \$20/SF (consistent with the MassDevelopment proforma for commercial space), or \$12,000 the first year

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Plymouth Multimodal Center
Land and Transit space benefit

Annual Rental Increase	3%										
				2023	2024	2025	2026	2027	2028	2029	2030
land value increase	3%	Existing lot	Improved*								
Value of Memorial Drive Parking lot		\$ 650,000.00	\$ 2,600,000.00	\$ 2,926,322.91	\$ 3,014,112.59	\$ 3,104,535.97	\$ 3,197,672.05	\$ 3,293,602.21	\$ 3,392,410.28	\$ 3,494,182.59	\$ 3,599,008.06
Net increase in value				\$ 85,232.71	\$ 87,789.69	\$ 90,423.38	\$ 93,136.08	\$ 95,930.16	\$ 98,808.07	\$ 101,772.31	\$ 104,825.48
Value of GATRA lease				\$13,506	\$13,911	\$14,329	\$14,758	\$15,201	\$15,657	\$16,127	\$16,611

Notes

Value of Memorial Drive parking lot based on 2012 Site Selection Study, Appendix J - Financial Feasibility, plus appreciation of 3% per year from 2011 when estimate was made, to 2015 when Project cost estimate was established. This cost is addressed as an in-kind donation by the Town of Plymouth as a Project Partner

Multiplier of 4 used for improved value of property based on Franklin Regional Transit Center, Greenfield, MA case study

2009 value of 12 Olive Street	\$ 890,000.00
2015 Developed value	\$ 3,551,000.00

3.99

GATRA will not pay rent for the 600 SF passenger waiting area. The value of the rent saved is estimated to be \$20/SF (consistent with the MassDevelopment proforma for commercial space), or \$12,000 the first year

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Plymouth Multimodal Center
Land and Transit space benefit

Annual Rental Increase	3%			2031	2032	2033	2034	2035	2036	2037	2038
land value increase	3%	Existing lot	Improved*								
Value of Memorial Drive Parking lot		\$ 650,000.00	\$ 2,600,000.00	\$ 3,706,978.31	\$ 3,818,187.65	\$ 3,932,733.28	\$ 4,050,715.28	\$ 4,172,236.74	\$ 4,297,403.84	\$ 4,426,325.96	\$ 4,559,115.74
Net increase in value				\$ 107,970.24	\$ 111,209.35	\$ 114,545.63	\$ 117,982.00	\$ 121,521.46	\$ 125,167.10	\$ 128,922.12	\$ 132,789.78
Value of GATRA lease				\$17,109	\$17,622	\$18,151	\$18,696	\$19,256	\$19,834	\$20,429	\$21,042

Notes

Value of Memorial Drive parking lot based on 2012 Site Selection Study, Appendix J - Financial Feasibility, plus appreciation of 3% per year from 2011 when estimate was made, to 2015 when Project cost estimate was established. This cost is addressed as an in-kind donation by the Town of Plymouth as a Project Partner

Multiplier of 4 used for improved value of property based on Franklin Regional Transit Center, Greenfield, MA case study

2009 value of 12 Olive Street \$ 890,000.00
2015 Developed value \$ 3,551,000.00

3.99

GATRA will not pay rent for the 600 SF passenger waiting area. The value of the rent saved is estimated to be \$20/SF (consistent with the MassDevelopment proforma for commercial space), or \$12,000 the first year

4-transit fare box

Plymouth Multimodal Center Transit Fare Box revenue

Fare Box Revenue	\$1.25	per rider in 2019				\$1.25	\$1.25	\$1.25	\$1.25	\$1.25
5-year increase in fare	5%									
	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
NO Build	\$1.25									
Manomet/Cedarville					\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Freedom					\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Mayflower					\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Liberty					\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Subtotal:		0	0	0	0	0	0	0	0	0
BUILD - Net New Riders										
Existing Routes	\$1.25	Growth Transit Center								
Manomet/Cedarville				\$ -	\$ 751.95	\$ 1,616.69	\$ 1,697.53	\$ 1,782.40	\$ 1,965.10	
Freedom				\$ -	\$ 2,513.93	\$ 5,404.94	\$ 5,675.19	\$ 5,958.95	\$ 6,569.74	
Mayflower				\$ -	\$ 2,705.44	\$ 5,816.70	\$ 6,107.54	\$ 6,412.91	\$ 7,070.24	
Liberty				\$ -	\$ 3,153.15	\$ 6,779.28	\$ 7,118.24	\$ 7,474.16	\$ 8,240.26	
Proposed Routes										
West Plymouth				\$ -	\$ 57,375.00	\$ 63,112.50	\$ 66,268.13	\$ 69,581.53	\$ 76,713.64	
Inter-City connector				\$ -	\$ 103,750.00	\$ 114,125.00	\$ 119,831.25	\$ 125,822.81	\$ 138,719.65	
Seasonal Connector				\$ -	\$ 49,000.00	\$ 53,900.00	\$ 56,595.00	\$ 59,424.75	\$ 65,515.79	
Subtotal of Additional Build Fare Box		-	-	-	-	219,249	250,755	263,293	276,458	304,794

Notes

Fare structure provided by GATRA. Current fare is \$1, assumed to be \$1.25 at project completion. Assumes fare increase of 5% every 5 years

4-transit fare box

Plymouth Multimodal Center Transit Fare Box revenue

Fare Box Revenue	\$1.25	per rider in 2019	\$1.31	\$1.31	\$1.31	\$1.31	\$1.31	\$1.38	\$1.38	\$1.38
5-year increase in fare	5%									
	2014		2024	2025	2026	2027	2028	2029	2030	2031
NO Build	\$1.25									
Manomet/Cedarville		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Freedom		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Mayflower		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Liberty		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Subtotal:		0	0	0	0	0	0	0	0	0
BUILD - Net New Riders										
Existing Routes	\$1.25	Growth Transit Center								
Manomet/Cedarville		\$ 2,063.35	\$ 2,166.52	\$ 2,274.85	\$ 2,388.59	\$ 2,627.45	\$ 2,758.82	\$ 2,896.76	\$ 3,041.60	
Freedom		\$ 6,898.23	\$ 7,243.14	\$ 7,605.30	\$ 7,985.56	\$ 8,784.12	\$ 9,223.33	\$ 9,684.49	\$ 10,168.72	
Mayflower		\$ 7,423.75	\$ 7,794.93	\$ 8,184.68	\$ 8,593.92	\$ 9,453.31	\$ 9,925.97	\$ 10,422.27	\$ 10,943.38	
Liberty		\$ 8,652.27	\$ 9,084.88	\$ 9,539.13	\$ 10,016.08	\$ 11,017.69	\$ 11,568.58	\$ 12,147.01	\$ 12,754.36	
Proposed Routes										
West Plymouth		\$ 80,549.32	\$ 84,576.79	\$ 88,805.63	\$ 93,245.91	\$ 102,570.50	\$ 107,699.02	\$ 113,083.97	\$ 118,738.17	
Inter-City connector		\$ 145,655.63	\$ 152,938.41	\$ 160,585.34	\$ 168,614.60	\$ 185,476.06	\$ 194,749.87	\$ 204,487.36	\$ 214,711.73	
Seasonal Connector		\$ 68,791.58	\$ 72,231.16	\$ 75,842.71	\$ 79,634.85	\$ 87,598.33	\$ 91,978.25	\$ 96,577.16	\$ 101,406.02	
Subtotal of Additional Build Fare Box		-	320,034	336,036	352,838	370,480	407,527	427,904	449,299	471,764

Notes

Fare structure provided by GATRA. Current fare is \$1, assumed to be \$1.25 at project completion. Assumes fare increase of 5% every 5 years

4-transit fare box

Plymouth Multimodal Center Transit Fare Box revenue

Fare Box Revenue	\$1.25	per rider in 2019	\$1.38	\$1.38	\$1.44	\$1.44	\$1.44	\$1.44	\$1.44
5-year increase in fare	5%								
	2014		2032	2033	2034	2035	2036	2037	2038
NO Build	\$1.25								
Manomet/Cedarville		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Freedom		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Mayflower		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Liberty		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Subtotal:		0	0	0	0	0	0	0	0
BUILD - Net New Riders									
Existing Routes	\$1.25	Growth Transit Center							
Manomet/Cedarville		\$ 3,193.68	\$ 3,505.79	\$ 3,681.08	\$ 3,865.13	\$ 4,058.39	\$ 4,261.31	\$ 4,474.38	
Freedom		\$ 10,677.15	\$ 11,720.60	\$ 12,306.63	\$ 12,921.96	\$ 13,568.06	\$ 14,246.46	\$ 14,958.79	
Mayflower		\$ 11,490.55	\$ 12,613.49	\$ 13,244.17	\$ 13,906.38	\$ 14,601.70	\$ 15,331.78	\$ 16,098.37	
Liberty		\$ 13,392.07	\$ 14,700.84	\$ 15,435.89	\$ 16,207.68	\$ 17,018.07	\$ 17,868.97	\$ 18,762.42	
Proposed Routes									
West Plymouth		\$ 124,675.08	\$ 136,859.24	\$ 143,702.20	\$ 150,887.31	\$ 158,431.67	\$ 166,353.26	\$ 174,670.92	
Inter-City connector		\$ 225,447.31	\$ 247,479.66	\$ 259,853.65	\$ 272,846.33	\$ 286,488.65	\$ 300,813.08	\$ 315,853.73	
Seasonal Connector		\$ 106,476.32	\$ 116,881.96	\$ 122,726.06	\$ 128,862.36	\$ 135,305.48	\$ 142,070.76	\$ 149,174.29	
Subtotal of Additional Build Fare Box		-	495,352	543,762	570,950	599,497	629,472	660,946	693,993

Notes

Fare structure provided by GATRA. Current fare is \$1, assumed to be \$1.25 at project completion. Assumes fare increase of 5% every 5 years

5-transitbenefit_travelsavings

Plymouth Multimodal Center Transit Travel Time Savings

[illegible]

Notes

Seasonal Connector

4.25 miles	total route	
1 mile	saved w circulator for heart of downtown	
3 mph	walk speed	0.33 hours to walk the route
18 mph	transit speed	0.1 hours to drive the route
	Travel time savings =	0.3 hours saved walking vs bus

Value of time
\$13.00 per hour Travel time value = \$3.61

TIGER BCA Resource Guide, updated 3/27/15 for all local travel purposes

Riders of all routes (existing plus new riders attracted to service) save time		
10 minutes	0.17	hours

less wait time due to improved connections	Travel time value =	\$2.17
--	---------------------	--------

2014		2025		2026		2027		2028		2029		2030		2031		2032		2033		2034			
Growth Transit Center																							
Existing Routes																							
Manomet/Cedarville		\$	40,256.20	\$	42,269.01	\$	44,382.46	\$	46,601.59	\$	48,931.66	\$	51,378.25	\$	53,947.16	\$	56,644.52	\$	59,476.74	\$	62,450.58		
Freedom		\$	134,585.01	\$	141,314.26	\$	148,379.97	\$	155,798.97	\$	163,588.92	\$	171,768.36	\$	180,356.78	\$	189,374.62	\$	198,843.35	\$	208,785.52		
Mayflower		\$	144,837.88	\$	152,079.78	\$	159,683.77	\$	167,667.96	\$	176,051.35	\$	184,853.92	\$	194,096.62	\$	203,801.45	\$	213,991.52	\$	224,691.10		
Liberty		\$	168,806.46	\$	177,246.78	\$	186,109.12	\$	195,414.58	\$	205,185.30	\$	215,444.57	\$	226,216.80	\$	237,527.64	\$	249,404.02	\$	261,874.22		
Proposed Routes																							
West Plymouth																							
Inter-City connector																							
Seasonal Connector		\$	198,731.22	\$	208,667.78	\$	219,101.17	\$	230,056.23	\$	241,559.04	\$	253,636.99	\$	266,318.84	\$	279,634.78	\$	293,616.52	\$	308,297.35		
Subtotal:		-	687,217		721,578		757,656		795,539		835,316		877,082		920,936		966,983		1,015,332		1,066,099		
Value of travel time savings		\$	-	\$	687,216.77	\$	721,577.61	\$	757,656.49	\$	795,539.31	\$	835,316.28	\$	877,082.09	\$	920,936.20	\$	966,983.01	\$	1,015,332.16	\$	1,066,098.77

Notes

Seasonal Connector

4.25 miles	total route	
1 mile	saved w circulator for heart of downtown	
3 mph	walk speed	0.33 hours to walk the route
18 mph	transit speed	0.1 hours to drive the route
	Travel time savings =	0.3 hours saved walking vs I

Value of time

\$13.00 per hour Travel time value = \$3.61

TIGER BCA Resource Guide, updated 3/27/15 for all local travel purposes

Riders of all routes (existing plus new riders attached to service) save time

10 minutes	0.17	hours
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less wait time due to

improved connections Travel time value = \$2.17

5-transitbenefit_travelsavings

Plymouth Multimodal Center Transit Travel Time Savings

2014		2035		2036	2037	2038

Notes

Seasonal Connector

4.25 miles	total route	
1 mile	saved w circulator for heart of downtown	
3 mph	walk speed	0.33 hours to walk the route
18 mph	transit speed	0.1 hours to drive the route
	Travel time savings =	0.3 hours saved walking vs transit

Value of time

\$13.00 per hour	Travel time value =	\$3.61
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TIGER BCA Resource Guide, updated 3/27/15 for all local travel purposes

Riders of all routes (existing plus new riders attracted to service) save time

10 minutes	0.17	hours
------------	------	-------

less wait time due to

<i>improved connections</i>	Travel time value =	\$2.17
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6-diverted auto trips

Diverted auto trips from Net New Transit Riders		<div><div>Initiate Construction</div><div>Construction Complete</div></div>											
		2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Existing Routes No Build	No Build												
Manomet/Cedarville		2,451	2,574	2,702	2,838	2,979	3,128	3,285	3,449	3,622	3,803	3,993	4,192
Freedom		8,195	8,605	9,035	9,487	9,961	10,459	10,982	11,531	12,107	12,713	13,348	14,016
Mayflower		8,819	9,260	9,723	10,209	10,720	11,256	11,818	12,409	13,030	13,681	14,365	15,084
Liberty		10,279	10,792	11,332	11,899	12,494	13,118	13,774	14,463	15,186	15,945	16,743	17,580
Existing Routes w growth	Growth Transit Center												
Manomet/Cedarville		-	-	-	-	-	3,121	3,433	3,605	3,785	3,975	4,173	4,601
Freedom		-	-	-	-	-	10,435	11,479	12,053	12,655	13,288	13,952	15,383
Mayflower		-	-	-	-	-	11,230	12,353	12,971	13,619	14,300	15,015	16,554
Liberty		-	-	-	-	-	13,089	14,397	15,117	15,873	16,667	17,500	19,294
Proposed Routes													
West Plymouth	(Route 3)	-	-	-	-	-	43,302	47,632	50,014	52,514	55,140	57,897	63,832
Inter-City connector	(Route 1)	-	-	-	-	-	78,302	86,132	90,439	94,961	99,709	104,694	115,425
Seasonal Connector	(Route 2)	-	-	-	-	-	13,067	14,373	15,092	15,847	16,639	17,471	19,262
	TOTAL	-	-	-	-	-	172,545.61	189,800.17	199,290.18	209,254.69	219,717.42	230,703.29	254,350.38

Notes

Assumes vehicle occupancy for standard trips

1.06

source: SRPEDD

Assumes vehicle occupancy for seasonal/tourism

3

Source: Plymouth Transportation Center Site Selection Study, Plymouth Convention Center and Visitor Bureau, 2012

Percent of transit riders diverted from vehicles on new routes

100%

SRPEDD (sheets 10, 11, 12)

Percent of transit riders diverted from vehicles on existing routes

25%

6-diverted auto trips

Diverted auto trips from Net New Transit Riders

		2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Existing Routes No Build		No Build											
	Manomet/Cedarville	4,402	4,622	4,853	5,096	5,351	5,618	5,899	6,194	6,504	6,829	7,170	7,529
	Freedom	14,717	15,453	16,225	17,036	17,888	18,783	19,722	20,708	21,743	22,830	23,972	25,171
	Mayflower	15,838	16,630	17,461	18,334	19,251	20,214	21,224	22,285	23,400	24,570	25,798	27,088
	Liberty	18,459	19,382	20,351	21,368	22,437	23,559	24,737	25,973	27,272	28,636	30,067	31,571
Existing Routes w growth		Growth Transit Center											
	Manomet/Cedarville	-	4,831	5,073	5,326	5,593	5,872	6,166	6,474	6,798	7,138	7,495	7,869
	Freedom	-	16,152	16,959	17,807	18,698	19,632	20,614	21,645	22,727	23,863	25,057	26,309
	Mayflower	-	17,382	18,251	19,164	20,122	21,128	22,184	23,294	24,458	25,681	26,965	28,314
	Liberty	-	20,259	21,272	22,335	23,452	24,624	25,856	27,148	28,506	29,931	31,428	32,999
Proposed Routes													
	West Plymouth	(Route 3)	-	67,023	70,374	73,893	77,588	81,467	85,540	89,817	94,308	99,024	103,975
	Inter-City connector	(Route 1)	-	121,196	127,256	133,619	140,300	147,315	154,681	162,415	170,536	179,062	188,016
	Seasonal Connector	(Route 2)	-	20,225	21,236	22,298	23,413	24,583	25,812	27,103	28,458	29,881	31,375
	TOTAL	-	267,067.90	280,421.30	294,442.36	309,164.48	324,622.70	340,853.84	357,896.53	375,791.36	394,580.92	414,309.97	435,025.47
													520,085.05

Notes

Assumes vehicle occupancy for standard trips

1.06

source: SRPEDD

Assumes vehicle occupancy for seasonal/tourism

3

Source: Plymouth Transportation Center Site Selection Study, Plymouth Convention Center and Visitor Bureau, 2012

Percent of transit riders diverted from vehicles on new routes

100%

SRPEDD (sheets 10, 11, 12)

Percent of transit riders diverted from vehicles on existing routes

25%

7-net new_diverted auto trips

Diverted auto trips from Net New Transit Riders		<div><div>Initiate Construction</div><div>Construction Complete</div></div>													
2013		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Existing Routes w growth	Growth Transit Center														
	Manomet/Cedarville						142	305	320	336	353	371	389	409	429
	Freedom						474	1,020	1,071	1,124	1,181	1,240	1,302	1,367	1,435
	Mayflower						510	1,097	1,152	1,210	1,270	1,334	1,401	1,471	1,544
	Liberty						595	1,279	1,343	1,410	1,481	1,555	1,633	1,714	1,800
Proposed Routes															
	West Plymouth (Route 3)	-	-	-	-	-	43,302	47,632	50,014	52,514	55,140	57,897	60,792	63,832	67,023
	Inter-City connector (Route 1)	-	-	-	-	-	78,302	86,132	90,439	94,961	99,709	104,694	109,929	115,425	121,196
	Seasonal Connector (Route 2)	-	-	-	-	-	13,067	14,373	15,092	15,847	16,639	17,471	18,344	19,262	20,225
	TOTAL	-	-	-	-	-	136,392.04	151,838.92	159,430.87	167,402.41	175,772.53	184,561.16	193,789.22	203,478.68	213,652.61

Notes

Assumes vehicle occupancy for standard trips

1.06

source: SRPEDD

Assumes vehicle occupancy for seasonal/tourism

3

Source: Plymouth Transportation Center Site Selection Study, Plymouth Convention Center and Visitor Bureau, 2012

Percent of transit riders diverted from vehicles on new routes

100%

Percent of transit riders diverted from vehicles

25%

7-net new_diverted auto trips

Diverted auto trips from Net New Transit Riders

2013		2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Existing Routes w growth	Growth Transit Center											
	Manomet/Cedarville	451	473	497	522	548	575	604	634	666	699	734
	Freedom	1,507	1,582	1,661	1,744	1,831	1,923	2,019	2,120	2,226	2,337	2,454
	Mayflower	1,621	1,703	1,788	1,877	1,971	2,069	2,173	2,282	2,396	2,515	2,641
	Liberty	1,890	1,984	2,084	2,188	2,297	2,412	2,533	2,659	2,792	2,932	3,078
Proposed Routes												
	West Plymouth (Route 3)	70,374	73,893	77,588	81,467	85,540	89,817	94,308	99,024	103,975	109,174	114,632
	Inter-City connector (Route 1)	127,256	133,619	140,300	147,315	154,681	162,415	170,536	179,062	188,016	197,416	207,287
	Seasonal Connector (Route 2)	21,236	22,298	23,413	24,583	25,812	27,103	28,458	29,881	31,375	32,944	34,591
TOTAL		224,335.24	235,552.00	247,329.60	259,696.08	272,680.89	286,314.93	300,630.68	315,662.21	331,445.32	348,017.59	365,418.47

Notes

Assumes vehicle occupancy for standard trips

1.06

source: SRPEDD

Assumes vehicle occupancy for seasonal/tourism

3

Source: Plymouth Transportation Center Site Selection Study, Plymouth Convention Center and Visitor Bureau, 2012

Percent of transit riders diverted from vehicles on new routes

100%

Percent of transit riders diverted from vehicles

25%

8-net new_diverted trips.VMT

Diverted VMT from Net New Transit Riders			Initiate Construction Construction Complete											
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Existing Routes	Growth Transit Center													
	Manomet/Cedarville					-	524.95	1,128.63	1,185.07	1,244.32	1,306.54	1,371.86	1,440.45	1,512.48
	Freedom					-	2,015.89	4,334.15	4,550.86	4,778.40	5,017.32	5,268.19	5,531.60	5,808.18
	Mayflower					-	3,930.55	8,450.68	8,873.21	9,316.87	9,782.72	10,271.85	10,785.44	11,324.72
	Liberty					-	2,528.47	5,436.22	5,708.03	5,993.43	6,293.10	6,607.75	6,938.14	7,285.05
Proposed Routes	West Plymouth	(Route 3)				-	227,767.92	250,544.72	263,071.95	276,225.55	290,036.83	304,538.67	319,765.60	335,753.88
	Inter-City connector	(Route 1)				-	399,339.62	439,273.58	461,237.26	484,299.13	508,514.08	533,939.79	560,636.78	588,668.62
	Seasonal Connector	(Route 2)				-	55,533.33	61,086.67	64,141.00	67,348.05	70,715.45	74,251.23	77,963.79	81,861.98
	TOTAL		-	-	-	-	-	691,640.73	770,254.65	808,767.38	849,205.75	891,666.04	936,249.34	983,061.81

Notes

Routes	Route milles	assumed VMT as % of route	50%
Puritan Link	7.4	3.7	
Freedom Link	8.5	4.25	
Mayflower Link	15.4	7.7	
Liberty Link	8.5	4.25	
West Plymouth	5.26	5.26	
Inter-City connector	5.10	5.10	
Seasonal Connector	4.25	4.25	
			(diverted auto trips VMT = bus route VMT: see SRPEDD sheets 10, 11, 12)
			100%

8-net new_diverted trips.VMT

Diverted VMT from Net New Transit Riders													
		2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Existing Routes													
	Growth Transit Center												
	Manomet/Cedarville	1,588.10	1,667.51	1,750.88	1,838.43	1,930.35	2,026.86	2,128.21	2,234.62	2,346.35	2,463.67	2,586.85	2,716.19
	Freedom	6,098.59	6,403.52	6,723.69	7,059.88	7,412.87	7,783.52	8,172.69	8,581.33	9,010.39	9,460.91	9,933.96	10,430.66
	Mayflower	11,890.95	12,485.50	13,109.77	13,765.26	14,453.53	15,176.20	15,935.01	16,731.76	17,568.35	18,446.77	19,369.11	20,337.56
	Liberty	7,649.30	8,031.77	8,433.35	8,855.02	9,297.77	9,762.66	10,250.79	10,763.33	11,301.50	11,866.58	12,459.90	13,082.90
Proposed Routes													
	West Plymouth (Route 3)	352,541.58	370,168.66	388,677.09	408,110.94	428,516.49	449,942.31	472,439.43	496,061.40	520,864.47	546,907.70	574,253.08	602,965.73
	Inter-City connector (Route 1)	618,102.05	649,007.15	681,457.51	715,530.38	751,306.90	788,872.25	828,315.86	869,731.65	913,218.23	958,879.15	1,006,823.10	1,057,164.26
	Seasonal Connector (Route 2)	85,955.07	90,252.83	94,765.47	99,503.74	104,478.93	109,702.88	115,188.02	120,947.42	126,994.79	133,344.53	140,011.76	147,012.35
	TOTAL	1,083,825.64	1,138,016.92	1,194,917.77	1,254,663.66	1,317,396.84	1,383,266.68	1,452,430.02	1,525,051.52	1,601,304.09	1,681,369.30	1,765,437.76	1,853,709.65

Notes

9-net divertedtripsautosavings

Auto Operating Savings from Diverted VMT from Net New Transit Riders

			Initiate Construction										Construction Complete																			
			2014		2015		2016		2017		2018		2019		2020		2021		2022		2023		2024		2025		2026		2027			
Existing Routes w growth			Growth Transit Center																													
			\$	-	\$	-	\$	-	\$	-	\$	-	\$	360.27	\$	797.81	\$	862.83	\$	933.15	\$	1,009.20	\$	1,091.45	\$	1,180.40	\$	1,276.61	\$	1,380.65		
Freedom			\$	-	\$	-	\$	-	\$	-	\$	-	\$	1,383.48	\$	3,063.72	\$	3,313.41	\$	3,583.46	\$	3,875.51	\$	4,191.36	\$	4,532.96	\$	4,902.40	\$	5,301.94		
Mayflower			\$	-	\$	-	\$	-	\$	-	\$	-	\$	2,697.50	\$	5,973.61	\$	6,460.46	\$	6,986.98	\$	7,556.42	\$	8,172.27	\$	8,838.31	\$	9,558.63	\$	10,337.66		
Liberty			\$	-	\$	-	\$	-	\$	-	\$	-	\$	1,735.27	\$	3,842.75	\$	4,155.93	\$	4,494.64	\$	4,860.95	\$	5,257.12	\$	5,685.57	\$	6,148.95	\$	6,650.09		
Proposed Routes																																
West Plymouth			(Route 3)	\$	-	\$	-	\$	-	\$	-	\$	-	\$	156,314.91	\$	177,104.79	\$	191,538.83	\$	207,149.24	\$	224,031.91	\$	242,290.51	\$	262,037.18	\$	283,393.21	\$	306,489.76	
Inter-City connector			(Route 1)	\$	-	\$	-	\$	-	\$	-	\$	-	\$	274,062.89	\$	310,513.25	\$	335,820.08	\$	363,189.42	\$	392,789.36	\$	424,801.69	\$	459,423.03	\$	496,866.01	\$	537,360.59	
Seasonal Connector			(Route 2)	\$	-	\$	-	\$	-	\$	-	\$	-	\$	38,111.99	\$	43,180.88	\$	46,700.12	\$	50,506.18	\$	54,622.43	\$	59,074.16	\$	63,888.71	\$	69,095.64	\$	74,726.93	
			TOTAL		-	-	-	-	-	-	-	-	-	474,666.29	544,476.80	588,851.66	636,843.07	688,745.79	744,878.57	805,586.17	871,241.44	942,247.62										

Notes

2014 vehicle operating costs \$ 0.592 per mile

source: American Automobile Association (AAA) 2014 "Your Driving Costs" for average sudan driven 15,000 miles per year

Estimate increase per year	3%	\$	0.61	\$	0.63	\$	0.65	\$	0.67	\$	0.69	\$	0.71	\$	0.73	\$	0.75	\$	0.77	\$	0.80	\$	0.82	\$	0.84	\$	0.87
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9-net divertedtripsautosavings

Auto Operating Savings from Diverted VMT from Net New Transit Riders

		2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Existing Routes w growth	Growth Transit Center											
	Manomet/Cedarville	\$ 1,493.17	\$ 1,614.87	\$ 1,746.48	\$ 1,888.82	\$ 2,042.76	\$ 2,209.24	\$ 2,389.29	\$ 2,584.02	\$ 2,794.62	\$ 3,022.38	\$ 3,268.70
	Freedom	\$ 5,734.05	\$ 6,201.38	\$ 6,706.79	\$ 7,253.39	\$ 7,844.54	\$ 8,483.87	\$ 9,175.31	\$ 9,923.10	\$ 10,731.83	\$ 11,606.47	\$ 12,552.40
	Mayflower	\$ 11,180.18	\$ 12,091.36	\$ 13,076.81	\$ 14,142.57	\$ 15,295.19	\$ 16,541.75	\$ 17,889.90	\$ 19,347.93	\$ 20,924.78	\$ 22,630.15	\$ 24,474.51
	Liberty	\$ 7,192.07	\$ 7,778.22	\$ 8,412.15	\$ 9,097.74	\$ 9,839.20	\$ 10,641.10	\$ 11,508.35	\$ 12,446.28	\$ 13,460.65	\$ 14,557.69	\$ 15,744.15
Proposed Routes												
	West Plymouth (Route 3)	\$ 331,468.68	\$ 358,483.37	\$ 387,699.77	\$ 419,297.30	\$ 453,470.03	\$ 490,427.84	\$ 530,397.71	\$ 573,625.12	\$ 620,375.57	\$ 670,936.18	\$ 725,617.47
	Inter-City connector (Route 1)	\$ 581,155.47	\$ 628,519.65	\$ 679,744.00	\$ 735,143.13	\$ 795,057.30	\$ 859,854.47	\$ 929,932.61	\$ 1,005,722.11	\$ 1,087,688.47	\$ 1,176,335.08	\$ 1,272,206.39
	Seasonal Connector (Route 2)	\$ 80,817.18	\$ 87,403.78	\$ 94,527.18	\$ 102,231.15	\$ 110,562.99	\$ 119,573.87	\$ 129,319.14	\$ 139,858.65	\$ 151,257.13	\$ 163,584.59	\$ 176,916.73
	TOTAL	1,019,040.80	1,102,092.63	1,191,913.18	1,289,054.10	1,394,112.01	1,507,732.14	1,630,612.31	1,763,507.21	1,907,233.05	2,062,672.54	2,230,780.35

Notes

2014 vehicle operating costs \$ 0.592 per mile

source: American Automobile Association (AAA) 2014 "Your Driving Costs" for average sudan driven 15,000 miles per year

Estimate increase per year	3%	\$ 0.90	\$ 0.92	\$ 0.95	\$ 0.98	\$ 1.01	\$ 1.04	\$ 1.07	\$ 1.10	\$ 1.13	\$ 1.17	\$ 1.20
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CMAQ New Bus Service Air Quality Analysis Worksheet

FILL IN SHADED BOXES ONLY

TIP YEAR: 2015

MPO: Southeastern Regional Planning & Economic Development District

RTA: Greater Attleboro Taunton Regional Transit Agency

Project: Plymouth Proposed Route 1 (Inter-City)

Summary of Vehicle Emission Rates:

Emission Rates by Vehicle Type	Milestone Year for Rates	Oper. Speed (mph)	Summer VOC (grams/mile)	Summer NOx (grams/mile)	Winter CO (grams/mile)	Summer CO2 (grams/mile)
Auto	2016	20	0.280	0.215	11.340	368.1
Bus*	2016	18	0.231	1.016	0.46	997.9
HDDV 4	Vehicle type used for Bus emission factors (For example, HDGV 6 or HDDV 2b)					

*Please refer to the 'Emission Factors' tab to determine the most appropriate 'Bus' factors based on fuel type and gross vehicle weight. If you require 'Bus' factors for an operating speed other than 18MPH, or for 'Auto' factors other than 20 MPH, please contact Ethan Britland at 857-368-8840 or at Ethan.Britland@state.ma.us

Calculate VMT and emissions savings from private vehicles:

Convert daily bus ridership into private auto VMT savings:

Daily one way person trips (reduced)	/ average veh. occupancy	= daily one-way auto trips	x avg. auto trip length (miles)	= daily savings auto VMT
250	1.06	236	5.1	1,203

Pollutant	Calculate emissions change from auto VMT savings:	Daily Auto VMT change (net)	X Emission factor (auto)	/ 1000g per kg	= change/day in kg
Summer VOC		-1,203	0.280	1000	-0.337
Summer NOx		-1,203	0.215	1000	-0.259
Winter CO		-1,203	11.340	1000	-13.640
Summer CO2		-1,203	368.100	1000	-442.762

Calculate bus route mileage and emissions per day:

Pollutant	Total Route distance (miles)	X # of round trips per day	= fleet miles per day	X Emission factor (bus)	/ 1000g per kg	= change/day in kg
Summer VOC	5.10	26	133	0.231	1000	0.031
Summer NOx	5.10	26	133	1.016	1000	0.135
Winter CO	5.10	20	102	0.460	1000	0.047
Summer CO2	5.10	26	133	997.90	1000	132.322

Add impact of bus emissions to emission savings from private vehicles

Pollutant	change/day auto (kg)	+ change/day bus or van (kg)	= change/day (NET) in kg
Summer VOC	-0.337	0.031	-0.306
Summer NOx	-0.259	0.135	-0.124
Winter CO	-13.640	0.047	-13.593
Summer CO2	-442.762	132.322	-310.440

Calculate net emissions change in kilograms per year (seasonally adjusted)

Pollutant	change/day (NET) in kg	X operating days per year	X seasonal adj factor	= change per year in kg
Summer VOC	-0.306	112	1.0188	-34.935
Summer NOx	-0.124	112	1.0188	-14.136
Winter CO	-13.593	218	0.9812	-2907.602
Summer CO2	-310.440	112	1.0000	-34769.308

Calculate cost effectiveness (cost per kg of emissions reduced)

Pollutant	Total Project Cost	/ Project Life in years	/ reduction per year in kg	= annual cost per kg
Summer VOC			34.935	#DIV/0!
Summer NOx			14.136	#DIV/0!
Winter CO			2907.602	#DIV/0!
Summer CO2			34769.308	#DIV/0!

10-plymouth rt 1

CMAQ New Bus Service Air Quality Analysis Worksheet

FILL IN SHADED BOXES ONLY

TIP YEAR: 2015

MPO: Southeastern Regional Planning & Economic Development District

RTA: Greater Attleboro Taunton Regional Transit Agency

Project: Plymouth Proposed Route 2 (Seasonal Circulator)

Summary of Vehicle Emission Rates:

Emission Rates by Vehicle Type	Milestone Year for Rates	Oper. Speed (mph)	Summer VOC (grams/mile)	Summer NOx (grams/mile)	Winter CO (grams/mile)	Summer CO2 (grams/mile)
Auto	2016	20	0.280	0.215	11.340	368.1
Bus*	2016	18	0.231	1.016	0.46	997.9
HDDV 4	Vehicle type used for Bus emission factors (For example, HDGV 6 or HDDV 2b)					

*Please refer to the 'Emission Factors' tab to determine the most appropriate 'Bus' factors based on fuel type and gross vehicle weight. If you require 'Bus' factors for an operating speed other than 18MPH, or for 'Auto' factors other than 20 MPH, please contact Ethan Britland at 857-368-8840 or at Ethan.Britland@state.ma.us

Calculate VMT and emissions savings from private vehicles:

Convert daily bus ridership into private auto VMT savings:

Daily one way person trips (reduced)	/ average veh. occupancy	= daily one-way auto trips	x avg. auto trip length (miles)	= daily savings auto VMT
927	1.06	875	4.25	3,717

Pollutant	Daily Auto VMT change (net)	X Emission factor (auto)	/ 1000g per kg	= change/day in kg
Summer VOC	-3,717	0.280	1000	-1.041
Summer NOx	-3,717	0.215	1000	-0.799
Winter CO	-3,717	11.340	1000	-42.148
Summer CO2	-3,717	368.100	1000	-1368.134

Calculate bus route mileage and emissions per day:

Pollutant	Total Route distance (miles)	X # of round trips per day	= fleet miles per day	X Emission factor (bus)	/ 1000g per kg	= change/day in kg
Summer VOC	4.25	32	136	0.231	1000	0.031
Summer NOx	4.25	32	136	1.016	1000	0.138
Winter CO	4.25	32	136	0.460	1000	0.063
Summer CO2	4.25	32	136	997.900	1000	135.714

Add impact of bus emissions to emission savings from private vehicles

Pollutant	change/day auto (kg)	+ change/day bus or van (kg)	= change/day (NET) in kg
Summer VOC	-1.041	0.031	-1.009
Summer NOx	-0.799	0.138	-0.661
Winter CO	-42.148	0.063	-42.085
Summer CO2	-1368.134	135.714	-1232.420

Calculate net emissions change in kilograms per year (seasonally adjusted)

Pollutant	change/day (NET) in kg	X operating days per year	X seasonal adj factor	= change per year in kg
Summer VOC	-1.009	112	1.0188	-115.164
Summer NOx	-0.661	112	1.0188	-75.415
Winter CO	-42.085	-	0.9812	0.000
Summer CO2	-1232.420	112	1.0000	-138030.988

Calculate cost effectiveness (cost per kg of emissions reduced)

Pollutant	Total Project	/ Project Life	/ reduction per	= annual cost
	Cost	in years	year in kg	per kg
Summer VOC			115.164	#DIV/0!
Summer NOx			75.415	#DIV/0!
Winter CO			0.000	#DIV/0!
Summer CO2			138030.988	#DIV/0!

(daily
passenges
input above)

11-plymouth rt 2

	10%		5%																		
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	
	350	385	404	424	446	468	491	516	542	569	597	627	658	691	726	762	800	840	882	927	
	41.25015	45.73364	48.19956	50.730	53.54772	56.36206	59.35939	62.51469	65.84529	69.30398	72.92425	76.7497	80.76642	84.98398	89.41242	94.02722	98.895	104.019	109.4539	115.1637	
	18.66013	22.10281	23.99629	25.939	28.10291	30.26392	32.56545	34.98827	37.54569	40.20147	42.98132	45.91872	49.00299	52.24147	55.64188	59.18538	62.92315	66.85764	71.03086	75.41516	
	0	0	0	0.000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	42654.19	48439.62	51621.6	54886.227	58522.78	62154.35	66022.07	70093.62	74391.36	78854.4	83525.94	88462.24	93645.35	99087.62	104802	110756.9	117038.2	123650.1	130663.2	138031	

CMAQ New Bus Service Air Quality Analysis Worksheet

FILL IN SHADED BOXES ONLY

TIP YEAR: 2015

MPO: Southeastern Regional Planning & Economic Development District

RTA: Greater Attleboro Taunton Regional Transit Agency

Project: Plymouth Proposed Route 3 (West Plymouth)

Summary of Vehicle Emission Rates:

Emission Rates by Vehicle Type	Milestone Year for Rates	Oper. Speed (mph)	Summer VOC (grams/mile)	Summer NOx (grams/mile)	Winter CO (grams/mile)	Summer CO2 (grams/mile)
Auto	2016	20	0.280	0.215	11.340	368.1
Bus*	2016	18	0.231	1.016	0.46	997.9
HDDV 4	Vehicle type used for Bus emission factors (For example, HDGV 6 or HDDV 2b)					

*Please refer to the 'Emission Factors' tab to determine the most appropriate 'Bus' factors based on fuel type and gross vehicle weight. If you require 'Bus' factors for an operating speed other than 18MPH, or for 'Auto' factors other than 20 MPH, please contact Ethan Britland at 857-368-8840 or at Ethan.Britland@state.ma.us

Calculate VMT and emissions savings from private vehicles:

Convert daily bus ridership into private auto VMT savings:

Daily one way person trips (reduced)	/ average veh. occupancy	= daily one-way auto trips	x avg. auto trip length (miles)	= daily savings auto VMT
397	1.06	375	5.26	1,970

Pollutant	Calculate emissions change from auto VMT savings:	Daily Auto VMT change (net)	X Emission factor (auto)	/ 1000g per kg	= change/day in kg
Summer VOC		-1,970	0.280	1000	-0.552
Summer NOx		-1,970	0.215	1000	-0.424
Winter CO		-1,970	11.340	1000	-22.340
Summer CO2		-1,970	368.100	1000	-725.164

Calculate bus route mileage and emissions per day:

Pollutant	Total Route distance (miles)	X # of round trips per day	= fleet miles per day	X Emission factor (bus)	/ 1000g per kg	= change/day in kg
Summer VOC	5.26	12	63	0.231	1000	0.015
Summer NOx	5.26	12	63	1.016	1000	0.064
Winter CO	5.26	12	63	0.460	1000	0.029
Summer CO2	5.26	12	120	997.900	1000	119.748

Add impact of bus emissions to emission savings from private vehicles

Pollutant	change/day auto (kg)	+ change/day bus or van (kg)	= change/day (NET) in kg
Summer VOC	-0.552	0.015	-0.537
Summer NOx	-0.424	0.064	-0.359
Winter CO	-22.340	0.029	-22.311
Summer CO2	-725.164	119.748	-605.416

Calculate net emissions change in kilograms per year (seasonally adjusted)

Pollutant	change/day (NET) in kg	X operating days per year	X seasonal adj factor	= change per year in kg
Summer VOC	-0.537	314	1.0188	-171.796
Summer NOx	-0.359	314	1.0188	-114.981
Winter CO	-22.311	314	0.9812	-6873.941
Summer CO2	-605.416	314	1.0000	-190100.607

Calculate cost effectiveness (cost per kg of emissions reduced)

Pollutant	Total Project Cost	/ Project Life in years	/ reduction per year in kg	= annual cost per kg
Summer VOC			171.796	#DIV/0!
Summer NOx			114.981	#DIV/0!
Winter CO			6873.941	#DIV/0!
Summer CO2			190100.607	#DIV/0!

12-plymouth rt 3

	10%		5%																	
	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
	150	165	173	182	191	201	211	221	232	244	256	269	282	296	311	327	343	360	378	397
62.00824	68.6755	72.3425	76.2317365	80.2321	84.67694	89.12178	93.56663	98.45596	103.7898	109.1236	114.9019	120.6802	126.903	133.5702	140.682	147.7937	155.35	163.3507	171.7959	
30.67971	35.79922	38.61494	41.6013242	44.67303	48.08603	51.49904	54.91204	58.66635	62.76196	66.85756	71.29447	75.73137	80.50958	85.62909	91.0899	96.5507	102.3528	108.4962	114.9809	
2591.641	2851.7	2994.732	3146.43319	3302.468	3475.841	3649.213	3822.586	4013.296	4221.342	4429.389	4654.774	4880.158	5122.879	5382.938	5660.334	5937.73	6232.463	6544.533	6873.941	
48432.43	57035.76	61767.59	66786.2039	71948.2	77683.76	83419.31	89154.86	95463.97	102346.6	109229.3	116685.5	124141.7	132171.5	140774.8	149951.7	159128.6	168879.1	179203.1	190100.6	

2016 Emission Factors for CMAQ Analysis
(all factors in g/day)

	Summer VOC	Summer NOx	Winter CO	Summer CO	Summer CO2
Intersection Analysis					
Idle	4.053	1.805	49.735		1414.95
Auto Emissions					
LDGV @ 20 mph	0.28	0.215	11.34	3.73	368.1
LDGV @ 35 mph	0.232	0.178	11.06	3.54	368.1
Bus/Truck Emissions					
HDGV 2b @ 18 mph	0.353	0.418	9.91		875.7
HDGV 3 @ 18 mph	0.556	0.703	12.73		945
HDGV 4 @ 18 mph	0.426	0.424	13.76		948.8
HDGV 5 @ 18 mph	0.76	0.743	15.94		1107.9
HDGV 6 @ 18 mph	0.699	0.672	16.03		1090.9
HDGV 7 @ 18 mph	0.69	0.757	17.81		1191.3
HDGV 8a @ 18 mph	0.644	0.884	19.38		1254.9
HDDV 2b @ 18 mph	0.169	0.615	0.296		785.4
HDDV 3 @ 18 mph	0.195	0.776	0.383		872.9
HDDV 4 @ 18 mph	0.231	1.016	0.46		997.9
HDDV 5 @ 18 mph	0.259	1.071	0.495		1030.6
HDDV 6 @ 18 mph	0.319	1.411	0.561		1168.8
HDDV 7 @ 18 mph	0.399	1.925	0.723		1351.6
HDDV 8a @ 18 mph	0.484	3.595	1.419		1545.7
HDDV 8b @ 18 mph	0.515	3.233	1.272		1616.5
HDGV 2b	8,501 to 10,000 lbs. Gross Vehicle Weight				
HDGV 3	10,001 to 14,000 lbs. Gross Vehicle Weight				
HDGV 4	14,001 to 16,000 lbs. Gross Vehicle Weight				
HDGV 5	16,001 to 19,500 lbs. Gross Vehicle Weight				
HDGV 6	19,501 to 26,000 lbs. Gross Vehicle Weight				
HDGV 7	26,001 to 33,000 lbs. Gross Vehicle Weight				
HDGV 8a	33,001 to 60,000 lbs. Gross Vehicle Weight				
HDDV 2b	8,501 to 10,000 lbs. Gross Vehicle Weight				
HDDV 3	10,001 to 14,000 lbs. Gross Vehicle Weight				
HDDV 4	14,001 to 16,000 lbs. Gross Vehicle Weight				
HDDV 5	16,001 to 19,500 lbs. Gross Vehicle Weight				
HDDV 6	19,501 to 26,000 lbs. Gross Vehicle Weight				
HDDV 7	26,001 to 33,000 lbs. Gross Vehicle Weight				
HDDV 8a	33,001 to 60,000 lbs. Gross Vehicle Weight				
HDDV 8b	Greater than 60,000 lbs. Gross Vehicle Weight				

14-emissions

Emission Type	\$/short ton (\$2013)	\$/metric ton (\$2013)	Metric ton per VMT	Miles per gallon of gas	kg/short ton	kg/metric ton
1 ton = lbs	2000	2,205		21.4	907.185	1000
VOCs	\$ 1,813.00	\$ 1,999.00				
Nox	\$ 7,147.00	\$ 7,877.00				
PM	\$ 326,935.00	\$ 350,383.00				
Sox	\$ 42,240.00	\$ 46,561.00				

Passenger vehicles per year - <http://www.epa.gov/cleanenergy/energy-resources/refs.html>

Passenger vehicles are defined as 2-axle 4-tire vehicles, including passenger cars, vans, pickup trucks, and sport/utility vehicles.

In 2011, the weighted average combined fuel economy of cars and light trucks combined was 21.4 miles per gallon (FHWA 2013). The average vehicle miles traveled in 2011 was 11,318 miles per year.

In 2011, the ratio of carbon dioxide emissions to total greenhouse gas emissions (including carbon dioxide, methane, and nitrous oxide, all expressed as carbon dioxide equivalents) for passenger vehicles was 0.988 (EPA 2013a, EPA 2013b).

The amount of carbon dioxide emitted per gallon of motor gasoline burned is 8.89×10^{-3} metric tons, as calculated in the "Gallons of gasoline consumed" section above.

source

TIGER BCA Resource Guide, updated 3/27/15 for all local travel purposes

15-Emissions savings_VOC																
Value of Emissions Savings VOC			<div><div>Initiate Construction</div><div>Construction Complete</div></div>													
			2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Existing Routes no build	Growth Transit Center	Manomet/Cedarville														
		Freedom														
		Mayflower														
		Liberty														
		TOTAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Existing Routes w growth	Growth Transit Center	Manomet/Cedarville														
		Freedom														
		Mayflower														
		Liberty														
		TOTAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Proposed Routes																
	West Plymouth	(Route 3)						123.92	137.25	144.58	152.35	160.34	169.23	178.11	186.99	196.76
	Inter-City connector	(Route 1)						69.82	77.50	81.80	86.10	90.71	95.62	100.84	106.37	111.90
	Seasonal Connector	(Route 2)						82.44	91.40	96.33	101.38	107.01	112.64	118.63	124.93	131.59
	TOTAL		-	-	-	-	-	276.18	306.14	322.70	339.83	358.06	377.49	397.58	418.30	440.26
			<div><div></div><div>\$ - \$ 276.18 \$ 306.14 \$ 322.70 \$ 339.83 \$ 358.06 \$ 377.49 \$ 397.58 \$ 418.30 \$ 440.26</div></div>													

Net New Riders Emissions Savings VOC		Initiate Construction Construction Complete														
		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	
Existing Routes w growth	Growth Transit Center															
	Manomet/Cedarville						1.04	2.25	2.37	2.50	2.62	2.80	2.92	3.04	3.23	
	Freedom						4.48	9.65	10.14	10.63	11.19	11.75	12.31	12.94	13.57	
	Mayflower						9.38	20.15	21.16	22.18	23.32	24.46	25.72	26.99	28.39	
	Liberty						5.95	12.80	13.43	14.06	14.76	15.53	16.30	17.14	17.98	
	TOTAL	\$ - \$ 20.83 \$ 44.85 \$ 47.11 \$ 49.36 \$ 51.88 \$ 54.54 \$ 57.25 \$ 60.11 \$ 63.16														

Value of Emissions Savings VOC

		2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Existing Routes no build	Growth Transit Center											
	Manomet/Cedarville											
	Freedom											
	Mayflower											
	Liberty											
TOTAL		-	-	-	-	-	-	-	-	-	-	-
Existing Routes w growth	Growth Transit Center											
	Manomet/Cedarville											
	Freedom											
	Mayflower											
	Liberty											
Proposed Routes												
West Plymouth	(Route 3)	207.42	218.08	229.63	241.18	253.61	266.94	281.15	295.36	310.47	326.45	343.33
Inter-City connector	(Route 1)	117.74	124.19	130.63	137.51	144.73	152.32	160.28	168.65	177.34	186.56	196.39
Seasonal Connector	(Route 2)	138.50	145.74	153.38	161.41	169.84	178.69	187.91	197.64	207.88	218.74	230.15
TOTAL		463.67	488.01	513.64	540.10	568.19	597.95	629.35	661.65	695.69	731.75	769.87

	\$	463.67	\$	488.01	\$	513.64	\$	540.10	\$	568.19	\$	597.95	\$	629.35	\$	661.65	\$	695.69	\$	731.75	\$	769.87
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Net New Riders Emissions Savings VOC

		2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Existing Routes w growth	Growth Transit Center											
	Manomet/Cedarville	3.35	3.53	3.71	3.90	4.08	4.32	4.51	4.75	4.99	5.24	5.48
	Freedom	14.27	14.97	15.74	16.51	17.35	18.19	19.09	19.44	21.05	22.10	23.22
	Mayflower	29.78	31.30	32.82	34.47	36.24	38.02	39.92	41.95	43.97	46.13	48.53
	Liberty	18.89	19.79	20.77	21.82	22.94	24.06	25.25	26.51	27.84	29.24	30.71
TOTAL		\$ 66.28	\$ 69.59	\$ 73.05	\$ 76.70	\$ 80.61	\$ 84.59	\$ 88.77	\$ 92.65	\$ 97.86	\$ 102.70	\$ 107.94

16-Emissions savings_Nox

Value of Emissions Savings Nox		Initiate Construction Construction Complete													
		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Existing Routes no build	Growth Transit Center														
	Manomet/Cedarville														
	Freedom														
	Mayflower														
	Liberty														
	TOTAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Existing Routes w growth	Growth Transit Center														
	Manomet/Cedarville														
	Freedom														
	Mayflower														
	Liberty														
Proposed Routes															
West Plymouth	(Route 3)						241.70	282.03	304.22	327.74	351.94	378.83	405.72	432.61	462.19
Inter-City connector	(Route 1)						111.37	134.62	147.63	160.65	174.60	189.48	205.29	222.03	238.76
Seasonal Connector	(Route 2)						147.01	174.13	189.05	204.35	221.40	238.43	256.56	275.65	295.79
	TOTAL	-	-	-	-	-	500.08	590.78	640.90	692.75	747.95	806.74	867.57	930.28	996.74
					\$ - \$ 500.08 \$ 590.78 \$ 640.90 \$ 692.75 \$ 747.95 \$ 806.74 \$ 867.57 \$ 930.28 \$ 996.74										

Net New Riders Emissions Savings Nox		Initiate Construction Construction Complete													
		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Existing Routes w growth	Growth Transit Center														
	Manomet/Cedarville						3.13	6.82	7.19	7.56	7.93	8.48	8.85	9.22	9.77
	Freedom						13.55	29.22	30.70	32.18	33.88	35.57	37.26	39.17	41.07
	Mayflower						28.39	60.99	64.06	67.13	70.58	74.03	77.87	81.70	85.92
	Liberty						18.00	38.74	40.65	42.56	44.67	47.00	49.33	51.87	54.41
TOTAL						\$ -	\$ 63.06	\$ 135.77	\$ 142.60	\$ 149.42	\$ 157.05	\$ 165.08	\$ 173.31	\$ 181.96	\$ 191.18

16-Emissions savings_Nox

Value of Emissions Savings Nox

		2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Existing Routes no build	Growth Transit Center											
	Manomet/Cedarville											
	Freedom											
	Mayflower											
	Liberty											
TOTAL		-	-	-	-	-	-	-	-	-	-	-
Existing Routes w growth	Growth Transit Center											
	Manomet/Cedarville											
	Freedom											
	Mayflower											
	Liberty											
Proposed Routes												
West Plymouth	(Route 3)	494.45	526.72	561.67	596.63	634.27	674.60	717.63	760.65	806.36	854.76	905.84
Inter-City connector	(Route 1)	256.43	275.96	295.44	316.27	338.13	361.10	385.21	410.52	436.83	464.73	494.49
Seasonal Connector	(Route 2)	316.72	338.62	361.76	386.06	411.57	438.36	466.28	495.72	526.72	559.60	594.14
TOTAL		1,067.60	1,141.30	1,218.87	1,298.95	1,383.98	1,474.06	1,569.11	1,666.89	1,769.91	1,879.08	1,994.47

\$	1,067.60	\$	1,141.30	\$	1,218.87	\$	1,298.95	\$	1,383.98	\$	1,474.06	\$	1,569.11	\$	1,666.89	\$	1,769.91	\$	1,879.08	\$	1,994.47
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Net New Riders Emissions Savings Nox

		2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Existing Routes w growth	Growth Transit Center											
	Manomet/Cedarville	10.14	10.69	11.24	11.80	12.35	13.09	13.64	14.38	15.11	15.85	16.59
	Freedom	43.19	45.31	47.64	49.97	52.51	55.05	57.80	58.86	63.73	66.90	70.29
	Mayflower	90.14	94.75	99.35	104.34	109.71	115.08	120.83	126.97	133.10	139.62	146.91
	Liberty	57.16	59.92	62.88	66.06	69.44	72.83	76.43	80.24	84.26	88.50	92.94
TOTAL		\$ 200.63	\$ 210.66	\$ 221.11	\$ 232.15	\$ 244.00	\$ 256.04	\$ 268.70	\$ 280.44	\$ 296.21	\$ 310.88	\$ 326.74

17-Emissions savings_Co2

Co2 Emissions		Initiate Construction														Construction Complete	
		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027		
Existing Routes no build	Growth Transit Center																
	Manomet/Cedarville																
	Freedom																
	Mayflower																
	Liberty																
	TOTAL	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Existing Routes w growth	Growth Transit Center																
	Manomet/Cedarville																
	Freedom																
	Mayflower																
	Liberty																
Proposed Routes																	
West Plymouth	(Route 3)						51.02	59.89	64.76	69.93	75.25	81.16	87.07	92.98	99.48		
Inter-City connector	(Route 1)						37.68	42.93	45.87	48.81	51.96	55.32	58.89	62.67	66.45		
Seasonal Connector	(Route 2)						42.65	48.44	51.62	54.89	58.52	62.15	66.02	70.09	74.39		
	TOTAL	-	-	-	-	-	131.36	151.25	162.25	173.63	185.73	198.63	211.98	225.74	240.32		
							-	131.36	151.25	162.25	173.63	185.73	198.63	211.98	225.74	240.32	

Net New Riders Emissions Savings CO2		<div><div>Initiate Construction</div><div>Construction Complete</div></div>													
		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Existing Routes w growth	Growth Transit Center														
	Manomet/Cedarville						0.69	1.50	1.58	1.66	1.74	1.86	1.94	2.03	2.15
	Freedom						2.98	6.42	6.75	7.07	7.44	7.82	8.19	8.61	9.03
	Mayflower						6.24	13.40	14.08	14.75	15.51	16.27	17.11	17.95	18.88
	Liberty						3.95	8.51	8.93	9.35	9.82	10.33	10.84	11.40	11.96
TOTAL						0.00	13.86	29.84	31.34	32.84	34.51	36.28	38.09	39.99	42.01
TOTAL							145.21	181.09	193.59	206.46	220.25	234.91	250.07	265.73	282.33

17-Emissions savings_Co2

Co2 Emissions

		2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Existing Routes no build	Growth Transit Center											
	Manomet/Cedarville											
	Freedom											
	Mayflower											
	Liberty											
TOTAL		-	-	-	-	-	-	-	-	-	-	-
Existing Routes w growth	Growth Transit Center											
	Manomet/Cedarville											
	Freedom											
	Mayflower											
	Liberty											
Proposed Routes												
West Plymouth	(Route 3)	106.57	113.66	121.34	129.02	137.29	146.16	155.61	165.07	175.11	185.75	196.97
Inter-City connector	(Route 1)	70.44	74.85	79.25	83.96	88.89	94.08	99.53	105.24	111.19	117.49	124.21
Seasonal Connector	(Route 2)	78.85	83.53	88.46	93.65	99.09	104.80	110.76	117.04	123.65	130.66	138.03
TOTAL		255.86	272.04	289.05	306.62	325.28	345.04	365.90	387.35	409.95	433.90	459.21

	255.86	272.04	289.05	306.62	325.28	345.04	365.90	387.35	409.95	433.90	459.21
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Net New Riders Emissions Savings CO2

		2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
Existing Routes w growth	Growth Transit Center											
	Manomet/Cedarville	2.23	2.35	2.47	2.59	2.71	2.88	3.00	3.16	3.32	3.48	3.65
	Freedom	9.49	9.96	10.47	10.98	11.54	12.10	12.70	12.93	14.00	14.70	15.45
	Mayflower	19.81	20.82	21.83	22.93	24.11	25.29	26.55	27.90	29.25	30.68	32.29
	Liberty	12.56	13.17	13.82	14.52	15.26	16.01	16.80	17.63	18.52	19.45	20.43
TOTAL		44.09	46.29	48.59	51.02	53.62	56.27	59.05	61.63	65.09	68.32	71.80
TOTAL		299.95	318.33	337.64	357.64	378.90	401.31	424.94	448.98	475.04	502.22	531.02

18-social cost of carbon

Social Cost of Carbon and Net Non-Co2 Benefits

Year	Calendar Year	Non CO2 Benefits (2013\$)	Non CO2 Costs (2013\$)	Net non CO2 Benefits	CO2		Reduced Metric Tons	3% SCC (2013\$)	Undiscounted CO2 costs @ 3% Avg SCC		NPV Co2 costs @ 3% Avg SCC	7% NPV Total Benefits	3% NPV Total Benefits	
					7% NPV Non CO2 Benefits	3% NPV Non CO2 Benefits								
0	2014			0	0	0			44	0.00	0	0	0	
1	2015			0	0	0			45	0.00	0	0	0	
2	2016			0	0	0			46	0.00	0	0	0	
3	2017			0	0	0			47	0.00	0	0	0	
4	2018			\$ -	0	0	-		49	\$ -	0	0	0	\$ - Total emissions value
5	2019			\$ 776.26	553.45949	477.41901	131.36		51	\$ 6,699.11	5778.7147	6332.1742	6256.1337	
6	2020			\$ 896.92	597.6575	500.52874	151.25		52	\$ 7,865.24	6587.0177	7184.6752	7087.5464	
7	2021			\$ 963.60	600.08101	487.92078	162.25		52	\$ 8,437.10	6860.1342	7460.2152	7348.055	
8	2022			\$ 1,032.58	600.97051	474.41167	173.63		54	\$ 9,375.87	7401.3995	8002.37	7875.8112	
9	2023			\$ 1,106.01	601.59641	461.07356	185.73		55	\$ 10,215.27	7829.1568	8430.7532	8290.2303	
10	2024			\$ 1,184.22	601.9999	447.94446	198.63		56	\$ 11,123.46	8276.8982	8878.8981	8724.8427	
11	2025			\$ 1,265.15	601.0633	434.22092	211.98		57	\$ 12,082.88	8728.9281	9329.9914	9163.1491	
12	2026			\$ 1,348.58	598.78651	419.97681	225.74		58	\$ 13,092.99	9183.1631	9781.9497	9603.14	
13	2027			\$ 1,437.00	596.30494	406.05465	240.32		60	\$ 14,419.16	9818.747	10415.052	10224.802	
14	2028			\$ 1,531.27	593.8522	392.60627	255.86		61	\$ 15,607.68	10318.516	10912.368	10711.122	
15	2029			\$ 1,629.31	590.53638	379.04283	272.04		62	\$ 16,866.26	10825.811	11416.347	11204.854	
16	2030			\$ 1,732.51	586.86121	365.7125	289.05		63	\$ 18,210.38	11348.105	11934.967	11713.818	
17	2031			\$ 1,839.05	582.19519	352.23766	306.62		63	\$ 19,317.21	11687.23	12269.425	12039.468	
18	2032			\$ 1,952.16	577.57443	339.26411	325.28		65	\$ 21,142.97	12419.265	12996.839	12758.529	
19	2033			\$ 2,072.01	572.92715	326.73235	345.04		66	\$ 22,772.67	12986.934	13559.861	13313.666	
20	2034			\$ 2,198.46	568.12269	314.55576	365.90		67	\$ 24,514.97	13573.345	14141.468	13887.901	
21	2035			\$ 2,328.54	562.37386	302.30366	387.35		68	\$ 26,339.70	14158.885	14721.259	14461.189	
22	2036			\$ 2,465.60	556.5175	290.44231	409.95		69	\$ 28,286.43	14762.476	15318.993	15052.918	
23	2037			\$ 2,610.84	550.74793	279.05943	433.90		71	\$ 30,806.78	15609.539	16160.287	15888.599	
24	2038			\$ 2,764.34	544.98058	268.09433	459.21		72	\$ 33,063.40	16265.003	16809.983	16533.097	
Totals						11638.609	7719.6018			350239.54	214419.27	226057.88	222138.87	

source:

TIGER BCA Resource Guide, updated 3/27/15

19-transit tourism \$

Tourism spending through increased transit

		Construction																
		Initiate Construction				Complete												
		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	
Existing Routes		Growth No-Build																
	Manomet/Cedarville																	
	Freedom																	
	Mayflower																	
	Liberty																	
Subtotal:		\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
Existing Routes		Growth Transit Center																
	Manomet/Cedarville																	
	Freedom																	
	Mayflower																	
	Liberty																	
Proposed Routes	West Plymouth																	
	Inter-City connector																	
	Seasonal Connector	\$ -	\$ -	\$ -	\$ -	\$ -	1,476,533.33	1,672,912.27	1,809,254.62	1,956,708.87	2,116,180.64	2,288,649.36	2,475,174.29	2,676,900.99	2,895,068.42	3,131,016.50	3,386,194.34	
Subtotal:		-	-	-	-	-	1,476,533	1,672,912	1,809,255	1,956,709	2,116,181	2,288,649	2,475,174	2,676,901	2,895,068	3,131,016	3,386,194	
Additional tourism dollars		\$ -	\$ -	\$ -	\$ -	\$ -	1,476,533.33	1,672,912.27	1,809,254.62	1,956,708.87	2,116,180.64	2,288,649.36	2,475,174.29	2,676,900.99	2,895,068.42	3,131,016.50	3,386,194.34	

Notes

Seasonal Connector	allows visitors to go to more tourism sites	2.00	more sites
Value of tourism expenditure per site		\$6	average cost of admission per transit rider
Retail expenditure		\$25.00	average expense on retail (Plymouth 400 Office)

Assuming 1,000,000¹ visitors to downtown attractions per year and a tourist season of 5 months (150 days), it is estimated that an average of 6,667 people visit downtown Plymouth daily. We assumed each visitor stayed about 3 hours in the downtown area. According to the Plymouth Convention Center and Visitor's Bureau, the average visitor stays in Plymouth for 4 hrs¹, but not all of that time is spent in the downtown (i.e. some time is spent at Plymouth Plantation and other non-downtown attractions).

The Plymouth Convention Center and Visitor's Bureau estimated that approximately 30% of visitors arrive by bus.

Plymouth 400				Adults	Seniors	Children	Family
visitors	2013 data	2020 Projections					
		1,500,000	6,000,000	Pilgrim Hall Mu	\$8	\$7	\$5
expenditures	350,000,000		1,400,000,000	Spooner House	\$6		\$3
				Hedge House	\$6		\$3
per capita	\$	233.33	\$	233.33	Mayflower Soci	\$7	\$5
				Jabez Howland	\$5	\$4	\$1
	Tourism marketing	ROI		Jenny Grist Mill	\$6		\$4
International travel	\$1	\$	23.00	Average	\$6		\$4
Domestic travel	\$1	\$	10.00				
Shopper will spend \$25 per person on local retail				Jenny Grist Mill	\$10		\$8
				Mayflower II	\$12	\$11	\$8

19-transit tourism \$

Tourism spending through increased transit

		2014			2030	2031	2032	2033	2034	2035	2036	2037	2038							
Existing Routes			Growth No-Build																	
	Manomet/Cedarville																			
	Freedom																			
	Mayflower																			
	Liberty																			
		Subtotal:	\$	-	\$	-	\$	-	\$	-	\$	-	\$	-						
Existing Routes			Growth Transit Center																	
	Manomet/Cedarville																			
	Freedom																			
	Mayflower																			
	Liberty																			
Proposed Routes																				
	West Plymouth																			
	Inter-City connector		\$	3,662,169.18	\$	3,960,635.97	\$	4,283,427.80	\$	4,632,527.17	\$	5,010,078.13	\$	5,418,399.50	\$	5,859,999.06	\$	6,337,588.98	\$	6,854,102.48
	Seasonal Connector		\$	3,662,169.18	\$	3,960,635.97	\$	4,283,427.80	\$	4,632,527.17	\$	5,010,078.13	\$	5,418,399.50	\$	5,859,999.06	\$	6,337,588.98	\$	6,854,102.48
		Subtotal:	3,662,169		3,960,636		4,283,428		4,632,527		5,010,078		5,418,399		5,859,999		6,337,589		6,854,102	
		Additional tourism dollars	\$	3,662,169.18	\$	3,960,635.97	\$	4,283,427.80	\$	4,632,527.17	\$	5,010,078.13	\$	5,418,399.50	\$	5,859,999.06	\$	6,337,588.98	\$	6,854,102.48

Notes	
Seasonal Connector	allows visitors to go to more tourism sites
Value of toursim expenditure per site	2.00 more sites
Retail expenditure	\$6 average cost of admission per transit rider
	\$25.00 average expense on retail (Plymouth 400 Office)
	3% increase per year

Assuming 1,000,000¹ visitors to downtown attractions per year and a tourist season of 5 months (150 days), it is estimated that an average of 6,667 people visit downtown Plymouth daily. We assumed each visitor stayed about 3 hours in the downtown area. According to the Plymouth Convention Center and Visitor’s Bureau, the average visitor stays in Plymouth for 4 hrs¹, but not all of that time is spent in the downtown (i.e. some time is spent at Plymouth Plantation and other non-downtown attractions).

The Plymouth Convention Center and Visitor’s Bureau estimated that approximately 30% of visitors arrive by bus.

Plymouth 400								
	2013 data	2020 Projections			Adults	Seniors	Children	Family
visitors	1,500,000		6,000,000		Pilgrim Hall Mu	\$8	\$7	\$5
expenditures	350,000,000		1,400,000,000		Spooner House	\$6		\$3
					Hedge House	\$6		\$3
per capita	\$ 233.33	\$	233.33		Mayflower Soci	\$7	\$5	\$5
					Jabez Howland	\$5	\$4	\$1
	Tourism marketing	ROI			Jenny Grist Mill	\$6		\$4
International travel	\$1	\$	23.00		Average	\$6		\$4
Domestic travel	\$1	\$	10.00					
Shopper will spend \$25 per person on local retail					Jenny Grist Mill	\$10		\$8
					Mayflower II	\$12	\$11	\$8

20-Job creation

Plymouth Multimodal Center
Job Creation for Transit

				Initiate Construction		Construction Complete											
Annual Wage Increase				2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
GATRA Bus Routes	# of Jobs	GATRA hourly rate	Annual salary														
	7	\$ 19.42	\$ 36,354.24	\$254,480	\$260,841.67	\$267,362.71	\$274,046.78	\$280,897.95	\$287,920.40	\$295,118.41	\$302,496.37	\$310,058.78	\$317,810.25	\$325,755.51	\$333,899.39	\$342,246.88	\$350,803.05
				\$0	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
TOTAL				\$254,479.68	\$260,841.67	\$267,362.71	\$274,046.78	\$280,897.95	\$287,920.40	\$295,118.41	\$302,496.37	\$310,058.78	\$317,810.25	\$325,755.51	\$333,899.39	\$342,246.88	\$350,803.05

20-Job creation

Plymouth Multimodal Center
Job Creation for Transit

Annual Wage Increase			2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
GATRA Bus Routes	# of Jobs	GATRA hourly rate											
	7	\$ 19.42	\$359,573.13 \$0.00	\$368,562.45 \$0.00	\$377,776.52 \$0.00	\$387,220.93 \$0.00	\$396,901.45 \$0.00	\$406,823.99 \$0.00	\$416,994.59 \$0.00	\$427,419.45 \$0.00	\$438,104.94 \$0.00	\$449,057.56 \$0.00	\$460,284.00 \$0.00
TOTAL			\$359,573.13	\$368,562.45	\$377,776.52	\$387,220.93	\$396,901.45	\$406,823.99	\$416,994.59	\$427,419.45	\$438,104.94	\$449,057.56	\$460,284.00

21-transit costs

Operating Costs	\$72.50	per hour	\$	72.50	\$	74.68	\$	76.92	\$	79.22	\$	81.60	\$	84.05	\$	86.57	\$	89.17	\$	91.84	\$	94.60	\$	97.43	\$	100.36	\$	103.37	
Operating Hours	13	per day																											
Operating Days	306	per year																											
Inflation	3.00%	per year																											
				Initiate Construction												Construction Complete													
				2015		2016		2017		2018		2019		2020		2021		2022		2023		2024		2025		2026			
Existing Routes	4	No Build			\$	1,188,228.60	\$	1,223,875.46	\$	1,260,591.72	\$	1,298,409.47	\$	1,337,361.76	\$	1,377,482.61	\$	1,418,807.09	\$	1,461,371.30	\$	1,505,212.44	\$	1,550,368.81	\$	1,596,879.88	\$	1,644,786.27	
O&M for existing shelter/curbspace	\$ 3,000.00	per year (source: GATRA)			\$	3,000.00	\$	3,090.00	\$	3,182.70	\$	3,278.18	\$	3,376.53	\$	3,477.82	\$	3,582.16	\$	3,689.62	\$	3,800.31	\$	3,914.32	\$	4,031.75	\$	4,152.70	
Subtotal Existing:					\$	1,191,228.60	\$	1,226,965.46	\$	1,263,774.42	\$	1,301,687.65	\$	1,340,738.28	\$	1,380,960.43	\$	1,422,389.25	\$	1,465,060.92	\$	1,509,012.75	\$	1,554,283.13	\$	1,600,911.63	\$	1,648,938.98	
Existing Routes - new center	4	Build										\$	1,337,361.76	\$	1,377,482.61	\$	1,418,807.09	\$	1,461,371.30	\$	1,505,212.44	\$	1,550,368.81	\$	1,596,879.88	\$	1,644,786.27		
Proposed Routes																													
West Plymouth													\$	308,621.94	\$	317,880.60	\$	327,417.02	\$	337,239.53	\$	347,356.72	\$	357,777.42	\$	368,510.74	\$	379,566.06	
Inter-City connector													\$	301,891.63	\$	310,948.38	\$	320,276.83	\$	329,885.13	\$	339,781.69	\$	349,975.14	\$	360,474.39	\$	371,288.62	
Seasonal Connector													\$	150,612.89	\$	155,131.27	\$	159,785.21	\$	164,578.77	\$	169,516.13	\$	174,601.62	\$	179,839.66	\$	185,234.85	
O&M for new transit center	\$ 9,019.46	per year										\$	9,019.46	\$	9,290.04	\$	9,568.75	\$	9,855.81	\$	10,151.48	\$	10,456.03	\$	10,769.71	\$	11,092.80		
Subtotal:					-	-	-	-					2,107,508	2,170,733	2,235,855	2,302,931	2,372,018	2,443,179	2,516,474	2,591,969									
Increase for Build from No Build					\$	-				\$	(1,301,687.65)	\$	766,769.39	\$	789,772.47	\$	813,465.65	\$	837,869.62	\$	863,005.71	\$	888,895.88	\$	915,562.75	\$	943,029.64		

Notes

\$72.50 Operating cost/hour from 2014 National Transit Database

\$ 9,019.46 O&M for new transit center

2% of capital cost of transit center \$ 450,973.00 RLB Cost Estimate June 2015

O&M for existing shelter provided by GATRA. Inclues maintenance of shelter, snow removal, etc.

Proposed Routes - developed by GATRA and SRPEDD

Year-Round		West Plymouth (Route 3)	Inter-City connector (Route 1)	Seasonal Connector (Route 2)
Days of service per		6		
Hours per day		12		
# roundtrips		12		
Days per year		306		
Daily one-way pers		150		
Summer				
Days of service per week		7	7	
Hours per day		13	16	
# roundtrips		26	32	
Days per year		112	112	
Daily one-way person trips		250	350	
Winter				
Days of service per week		6		
Hours per day		10		
# roundtrips		20		
Days per year		220		
Daily one-way person trips		250		

21-transit costs

Operating Costs	\$72.50	per hour		\$	106.47	\$	109.66	\$	112.95	\$	116.34	\$	119.83	\$	123.43	\$	127.13	\$	130.94	\$	134.87	\$	138.92	\$	143.09	\$	147.38
Operating Hours	13	per day																									
Operating Days	306	per year																									
Inflation	3.00%	per year																									

			2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037
Existing Routes	4	No Build	\$ 1,694,129.86	\$ 1,744,953.76	\$ 1,797,302.37	\$ 1,851,221.44	\$ 1,906,758.09	\$ 1,963,960.83	\$ 2,022,879.65	\$ 2,083,566.04	\$ 2,146,073.02	\$ 2,210,455.21	\$ 2,276,768.87
O&M for existing shelter/ curbspace	\$ 3,000.00	per year (source: GATRA)	\$ 4,277.28	\$ 4,405.60	\$ 4,537.77	\$ 4,673.90	\$ 4,814.12	\$ 4,958.54	\$ 5,107.30	\$ 5,260.52	\$ 5,418.33	\$ 5,580.88	\$ 5,748.31
Subtotal Existing:			\$ 1,698,407.15	\$ 1,749,359.36	\$ 1,801,840.14	\$ 1,855,895.34	\$ 1,911,572.20	\$ 1,968,919.37	\$ 2,027,986.95	\$ 2,088,826.56	\$ 2,151,491.36	\$ 2,216,036.10	\$ 2,282,517.18

Existing Routes - new center	4	Build	\$ 1,694,129.86	\$ 1,744,953.76	\$ 1,797,302.37	\$ 1,851,221.44	\$ 1,906,758.09	\$ 1,963,960.83	\$ 2,022,879.65	\$ 2,083,566.04	\$ 2,146,073.02	\$ 2,210,455.21	\$ 2,276,768.87	\$ 2,345,071.94
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Proposed Routes																									
	West Plymouth	\$	390,953.05	\$	402,681.64	\$	414,762.09	\$	427,204.95	\$	440,021.10	\$	453,221.73	\$	466,818.38	\$	480,822.93	\$	495,247.62	\$	510,105.05	\$	525,408.20	\$	541,170.45
	Inter-City connector	\$	382,427.28	\$	393,900.10	\$	405,717.10	\$	417,888.61	\$	430,425.27	\$	443,338.03	\$	456,638.17	\$	470,337.32	\$	484,447.44	\$	498,980.86	\$	513,950.29	\$	529,368.79
	Seasonal Connector	\$	190,791.90	\$	196,515.66	\$	202,411.13	\$	208,483.46	\$	214,737.96	\$	221,180.10	\$	227,815.51	\$	234,649.97	\$	241,689.47	\$	248,940.15	\$	256,408.36	\$	264,100.61
O&M for new transit center	<div><div>\$ 9,019.46</div>per year</div>	\$	11,425.58	\$	11,768.35	\$	12,121.40	\$	12,485.04	\$	12,859.59	\$	13,245.38	\$	13,642.74	\$	14,052.02	\$	14,473.59	\$	14,907.79	\$	15,355.03	\$	15,815.68
Subtotal:			2,669,728	2,749,820	2,832,314	2,917,284	3,004,802	3,094,946	3,187,794	3,283,428	3,381,931	3,483,389	3,587,891	3,695,527											

Increase for Build from No Build	\$ 971,320.52	\$ 1,000,460.14	\$ 1,030,473.94	\$ 1,061,388.16	\$ 1,093,229.81	\$ 1,126,026.70	\$ 1,159,807.50	\$ 1,194,601.73	\$ 1,230,439.78	\$ 1,267,352.97	\$ 1,305,373.56	\$ 1,345,527.47
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Notes

\$72.50 Operating cost/hour from 2014 National Transit Database

\$ 9,019.46 O&M for new transit center

2% of capital cost of transit center \$ 450,973.00 RLB Cost Estimate June 2015

O&M for existing shelter provided by GATRA. Inclues maintenance of shelter, snow removal, etc.

Proposed Routes - developed by GATRA and SRPEDD

		West Plymouth (Route 3)	Inter-City connector (Route 1)	Seasonal Connector (Route 2)
Year-Round	Days of service per	6		
	Hours per day	12		
	# roundtrips	12		
	Days per year	306		
	Daily one-way pers	150		
Summer	Days of service per week		7	7
	Hours per day		13	16
	# roundtrips		26	32
	Days per year		112	112
	Daily one-way person trips		250	350
Winter	Days of service per week		6	
	Hours per day		10	
	# roundtrips		20	
	Days per year		220	
	Daily one-way person trips		250	

Multimodal Center

Development Summary /Sources & Uses

Updated May 2015

Notes

Financials Summary

COSTS

Land	\$	650,000
Rolling stock	\$	1,230,000
Hard	\$	23,323,125
Soft	\$	3,388,600
Financing	\$	240,500
TDC	\$	28,832,225

SOURCES

Town of Plymouth (land)	\$	650,000	
GATRA (TIGER)	\$	14,294,573	
GATRA (Rolling Stock)	\$	1,230,000	
MassDOT (T-Bond Bill)	\$	8,000,000	
PGDC--Equity	\$	472,528	<i>initial estimate from PGDC/MassDevelopment</i>
PGDC--Bond	\$	3,025,224	
Commercial Area master lease	\$	1,159,900	<i>initial estimate from PGDC/MassDevelopment</i>
Total	\$	28,832,225	

23-PT&VC Costs_5% for 2015_prop

Multimodal Center

Project Costs

Updated May 2015

Notes

Property Acquisition and Preparation

Property						\$	650,000		Donated by the Town of Plymouth
Rolling Stock						\$	1,230,000		\$410,000 for three buses
Base--Utilities runs for air rights tower	845	lf	\$	-	plf	\$	-		
Base--Structure for air rights tower	65	lf	\$	-	plf	\$	-		
Base--Foundations for air rights tower	5,920	sf	\$	-	psf	\$	-		
Total Property Acquisition and Preparation						\$	1,880,000		

Hard Costs

			2014 Est		escalation to 2015				
Construction Costs			\$	17,770,000.00	5%	\$	18,658,500		RLB June 2014 estimate
Contingency	25%					\$	4,664,625		
Total Hard Costs						\$	23,323,125		

Soft Costs

Architectural & Engineering	10%					\$	1,865,850		
Survey						\$	5,000		
Geotechnical Engineering						\$	20,000		Geotech survey, borings and foundation recs.
Hazmat Survey						\$	10,000		
Traffic Engineering						\$	25,000		
Civil Engineering						\$	30,000		includes permitting work, shared
Legal-Permitting	9	mos	\$	7,500	p/mo	\$	75,000		
Legal-Transaction						\$	35,000		includes acquisition, P&S for comm'l
Legal-Bond						\$	150,000		
Property Title Insurance						\$	10,000		estimate
General Accounting						\$	40,000		estimate
Permits & Fees	1.5%		of Hard Costs			\$	279,878		building permit, utility connection fees, etc.
RE Taxes during development						\$	-		tax exempt
OH & Project Management	2.5%		of Dev Costs			\$	606,401		
Contingency	7.5%		of Soft			\$	236,410		
Total Soft Costs						\$	3,388,538	\$	3,388,600

Financing Costs

Bond	22.32%					\$	5,000,000		
Interest: 4.2%, 12 mo., 55% loan balance avg. outstanding, int. only						\$	115,500		\$0.00
Bond Fees @	2.5%					\$	125,000		\$0.00
Total Financing and Reserves						\$	240,500		

TOTAL DEVELOPMENT COSTS WITH
FINANCING

\$ 28,832,225

Operating Proforma

Source: PGDC and MassDevelopment

Annual Revenue and Operating Expense Assumptions

REVENUE									
Parking	capital contribution, CAM only					\$525,000	2012 Site Selection Study for seasonal variation		
GATRA-Transit Center Lease						\$0	GATRA-Transit Center CAM Share		
New Court Street Area Meter Revenue						\$160,000	PGDC, based on Plymouth Parking Management Plan, 2012		
Vending	150	\$	2.00	260	35.0%	\$27,300	PGDC		
Visitor Center--Operating cost reimbursement	within Commercial Component					\$0			
Commercial	Capital Contribution					\$0	Annual increase		
Subtotal: Gross Revenues						\$712,300	3%		
OPERATING EXPENSE									
Garage	\$	65.00	/space	394	spaces	\$307,320			
GATRA-Transit Center									
Major repair & renewal Fund						\$50,000			
Commercial & Visitor Center	within Commercial Component--Master Lessee responsibility						Annual increase		
Subtotal-Operating Expense						\$357,320	3%		
Net Operating Income						\$354,980			
Debt Service						\$320,060			
Cash Flow After Debt Service						\$34,920			

Permanent Debt Service Assumptions

	DS Coverage	Interest	Amortization	Payment (P+I)	Loan Amount
Revenue Bonds-Tax Exempt	1.50	6.00%	25	\$ 236,653	\$ 3,025,224
Value at stabilization	5.0% cap rate on NOI				\$ 7,099,600

Multimodal Center: Commercial Component

Commercial Operating Proforma **DRAFT**

Source: PGDC and MassDevelopment

Rental Revenues and Operating Expenses Assumptions					

Existing Bus Service Air Quality Analysis Worksheet for Net New Riders

26- Puritan

(based on SRPEDD methodolgy for calcuations)

FILL IN SHADED BOXES ONLY

Route: Puritan Link (Manoment to Cedarville)

Summary of Vehicle Emission Rates:

Emission Rates by Vehicle Type	Milestone Year for Rates	Oper. Speed (mph)	Summer VOC (grams/mile)	Summer NOx (grams/mile)	Winter CO (grams/mile)	Summer CO2 (grams/mile)
Auto	2016	20	0.280	0.215	11.340	368.1
Bus*	2016	18	0.231	1.016	0.46	997.9
HDDV 4	Vehicle type used for Bus emission factors (For example, HDGV 6 or HDDV 2b)					

*Please refer to the 'Emission Factors' tab to determine the most appropriate 'Bus' factors based on fuel type and gross vehicle weight. If you require 'Bus' factors for an operating speed other than 18MPH, or for 'Auto' factors other than 20 MPH, please contact Ethan Britland at 857-368-8840 or at Ethan.Britland@state.ma.us

Calculate VMT and emissions savings from private vehicles:

Convert daily bus ridership into private auto VMT savings:

Daily one way person trips (reduced)	/ average veh. occupancy	= daily one-way auto trips	x avg. auto trip length (miles)	= daily savings auto VMT
9.0	1.06	8	3.7	31

Calculate emissions change from auto VMT savings:	Daily Auto VMT change (net)	X Emission factor (auto)	/ 1000g per kg	= change/day in kg
Summer VOC	-31	0.280	1000	-0.009
Summer NOx	-31	0.215	1000	-0.007
Winter CO	-31	11.340	1000	-0.356
Summer CO2	-31	368.100	1000	-11.564

Calculate bus route mileage and emissions per day:						
Pollutant	Total Route distance (miles)	X # of round trips per day	= fleet miles per day	X Emission factor (bus)	/ 1000g per kg	= change/day in kg
Summer VOC	3.70	12	44	0.231	1000	0.000
Summer NOx	3.70	12	44	1.016	1000	0.000
Winter CO	3.70	12	44	0.460	1000	0.000
Summer CO2	3.70	12	120	997.900	1000	0.000

Add impact of bus emissions to emission savings from private vehicles

Pollutant	change/day auto (kg)	+ change/day bus or van (kg)	= change/day (NET) in kg
Summer VOC	-0.009	0.000	-0.009
Summer NOx	-0.007	0.000	-0.007
Winter CO	-0.356	0.000	-0.356
Summer CO2	-11.564	0.000	-11.564

Calculate net emissions change in kilograms per year (seasonally adjusted)

Pollutant	change/day (NET) in kg	X operating days per year	X seasonal adj factor	= change per year in kg
Summer VOC	-0.009	306	1.0188	-2.742
Summer NOx	-0.007	306	1.0188	-2.106
Winter CO	-0.356	306	0.9812	-106.962
Summer CO2	-11.564	306	1.0000	-3538.552

Calculate cost effectiveness (cost per kg of emissions reduced)

Pollutant	Total Project Cost	/ Project Life in years	/ reduction per year in kg	= annual cost per kg
Summer VOC			2.742	#DIV/0!
Summer NOx			2.106	#DIV/0!
Winter CO			106.962	#DIV/0!
Summer CO2			3538.552	#DIV/0!

2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
2.0	4.2	4.4	4.7	4.9	5.1	5.4	5.7	5.9	6.2	6.6	6.9	7.2	7.6	8.0	8.4	8.8	9.2	9.7	10.2
0.51798	1.127	1.188308	1.24924641	1.310185	1.401594	1.462532	1.523471	1.61488	1.675818	1.767227	1.858635	1.950043	2.041451	2.163329	2.254737	2.376615	2.498493	2.620371	2.742248
0.397735	0.866	0.91245	0.95924278	1.006035	1.076224	1.123016	1.169808	1.239997	1.286789	1.356978	1.427166	1.497355	1.567543	1.661128	1.731316	1.824901	1.918486	2.01207	2.105655
20.20397	43.973	46.35029	48.7272314	51.10417	54.66958	57.04651	59.42345	62.98886	65.3658	68.93121	72.49661	76.06202	79.62743	84.3813	87.94671	92.70059	97.45446	102.2083	106.9622
668.3932	1454.738	1533.373	1612.00713	1690.642	1808.593	1887.228	1965.862	2083.814	2162.449	2280.4	2398.352	2516.304	2634.256	2791.525	2909.476	3066.745	3224.014	3381.283	3538.552

Existing Bus Service Air Quality Analysis Worksheet for Net New Riders
(based on SRPEDD methodolgy for calcuations)

FILL IN SHADED BOXES ONLY

Route: Freedom Link

Summary of Vehicle Emission Rates:

Emission Rates by Vehicle Type	Milestone Year for Rates	Oper. Speed (mph)	Summer VOC (grams/mile)	Summer NOx (grams/mile)	Winter CO (grams/mile)	Summer CO2 (grams/mile)
Auto	2016	20	0.280	0.215	11.340	368.1
Bus*	2016	18	0.231	1.016	0.46	997.9
HDDV 4	Vehicle type used for Bus emission factors (For example, HDGV 6 or HDDV 2b)					

*Please refer to the 'Emission Factors' tab to determine the most appropriate 'Bus' factors based on fuel type and gross vehicle weight. If you require 'Bus' factors for an operating speed other than 18MPH, or for 'Auto' factors other than 20 MPH, please contact Ethan Britland at 857-368-8840 or at Ethan.Britland@state.ma.us

Calculate VMT and emissions savings from private vehicles:

Convert daily bus ridership into private auto VMT savings:

Daily one way person trips (reduced)	/ average veh. occupancy	= daily one-way auto trips	x avg. auto trip length (miles)	= daily savings auto VMT
33.2	1.06	31	4.25	133

Pollutant	Calculate emissions change from auto VMT savings:	Daily Auto VMT change (net)	X Emission factor (auto)	/ 1000g per kg	= change/day in kg
Summer VOC		-133	0.280	1000	-0.037
Summer NOx		-133	0.215	1000	-0.029
Winter CO		-133	11.340	1000	-1.510
Summer CO2		-133	368.100	1000	-48.999

Calculate bus route mileage and emissions per day:						
Pollutant	Total Route distance (miles)	X # of round trips per day	= fleet miles per day	X Emission factor (bus)	/ 1000g per kg	= change/day in kg
Summer VOC	4.25	12	51	0.231	1000	0.000
Summer NOx	4.25	12	51	1.016	1000	0.000
Winter CO	4.25	12	51	0.460	1000	0.000
Summer CO2	4.25	12	120	997.900	1000	0.000

Add impact of bus emissions to emission savings from private vehicles

Pollutant	change/day auto (kg)	+ change/day bus or van (kg)	= change/day (NET) in kg
Summer VOC	-0.037	0.000	-0.037
Summer NOx	-0.029	0.000	-0.029
Winter CO	-1.510	0.000	-1.510
Summer CO2	-48.999	0.000	-48.999

Calculate net emissions change in kilograms per year (seasonally adjusted)

Pollutant	change/day (NET) in kg	X operating days per year	X seasonal adj factor	= change per year in kg
Summer VOC	-0.037	306	1.0188	-11.620
Summer NOx	-0.029	306	1.0188	-8.922
Winter CO	-1.510	306	0.9812	-453.224
Summer CO2	-48.999	306	1.0000	-14993.685

Calculate cost effectiveness (cost per kg of emissions reduced)

Pollutant	Total Project Cost	/ Project Life in years	/ reduction per year in kg	= annual cost per kg
Summer VOC			11.620	#DIV/0!
Summer NOx			8.922	#DIV/0!
Winter CO			453.224	#DIV/0!
Summer CO2			14993.685	#DIV/0!

27- Freedom

	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
	6.6	14.1	14.8	15.6	16.4	17.2	18.0	18.9	19.9	20.9	21.9	23.0	24.2	25.4	26.6	28.0	29.4	30.8	32.4	34.0
	2.240	4.829816	5.074806	5.31979684	5.599786	5.879775	6.159765	6.474753	6.789741	7.139727	7.489714	7.874699	8.259685	8.679669	9.099652	9.554635	9.729628	10.5346	11.05958	11.61956
	1.720	3.708608	3.896726	4.084844	4.299836	4.514828	4.729819	4.971685	5.213551	5.482291	5.75103	6.046644	6.342258	6.664745	6.987233	7.336595	7.470965	8.089066	8.492176	8.922159
	87.369	188.3884	197.9443	207.500273	218.4213	229.3424	240.2635	252.5497	264.8359	278.4872	292.1385	307.155	322.1715	338.5531	354.9347	372.6814	379.5071	410.9051	431.3821	453.2243
	2890.349	6232.315	6548.447	6864.57883	7225.872	7587.166	7948.46	8354.915	8761.37	9212.987	9664.604	10161.38	10658.16	11200.1	11742.04	12329.14	12554.95	13593.67	14271.1	14993.69

Existing Bus Service Air Quality Analysis Worksheet for Net New Riders
(based on SRPEDD methodology for calculations)

FILL IN SHADED BOXES ONLY

Route: Mayflower Link

Summary of Vehicle Emission Rates:

Emission Rates by Vehicle Type	Milestone Year for Rates	Oper. Speed (mph)	Summer VOC (grams/mile)	Summer NOx (grams/mile)	Winter CO (grams/mile)	Summer CO2 (grams/mile)
Auto	2016	20	0.280	0.215	11.340	368.1
Bus*	2016	18	0.231	1.016	0.46	997.9
HDDV 4	Vehicle type used for Bus emission factors (For example, HDGV 6 or HDDV 2b)					

*Please refer to the 'Emission Factors' tab to determine the most appropriate 'Bus' factors based on fuel type and gross vehicle weight. If you require 'Bus' factors for an operating speed other than 18MPH, or for 'Auto' factors other than 20 MPH, please contact Ethan Britland at 857-368-8840 or at Ethan.Britland@state.ma.us

Calculate VMT and emissions savings from private vehicles:

Convert daily bus ridership into private auto VMT savings:

Daily one way person trips (reduced)	/ average veh. occupancy	= daily one-way auto trips	x avg. auto trip length (miles)	= daily savings auto VMT
38.3	1.06	36	7.7	278

Pollutant	Calculate emissions change from auto VMT savings:	Daily Auto VMT change (net)	X Emission factor (auto)	/ 1000g per kg	= change/day in kg
Summer VOC		-278	0.280	1000	-0.078
Summer NOx		-278	0.215	1000	-0.060
Winter CO		-278	11.340	1000	-3.155
Summer CO2		-278	368.100	1000	-102.412

Calculate bus route mileage and emissions per day:

Pollutant	Total Route distance (miles)	X # of round trips per day	= fleet miles per day	X Emission factor (bus)	/ 1000g per kg	= change/day in kg
Summer VOC	7.70	12	92	0.231	1000	0.000
Summer NOx	7.70	12	92	1.016	1000	0.000
Winter CO	7.70	12	92	0.460	1000	0.000
Summer CO2	7.70	12	120	997.900	1000	0.000

Add impact of bus emissions to emission savings from private vehicles

Pollutant	change/day auto (kg)	+ change/day bus or van (kg)	= change/day (NET) in kg
Summer VOC	-0.078	0.000	-0.078
Summer NOx	-0.060	0.000	-0.060
Winter CO	-3.155	0.000	-3.155
Summer CO2	-102.412	0.000	-102.412

Calculate net emissions change in kilograms per year (seasonally adjusted)

Pollutant	change/day (NET) in kg	X operating days per year	X seasonal adj factor	= change per year in kg
Summer VOC	-0.078	306	1.0188	-24.286
Summer NOx	-0.060	306	1.0188	-18.648
Winter CO	-3.155	306	0.9812	-947.274
Summer CO2	-102.412	306	1.0000	-31337.971

Calculate cost effectiveness (cost per kg of emissions reduced)

Pollutant	Total Project Cost	/ Project Life in years	/ reduction per year in kg	= annual cost per kg
Summer VOC			24.286	#DIV/0!
Summer NOx			18.648	#DIV/0!
Winter CO			947.274	#DIV/0!
Summer CO2			31337.971	#DIV/0!

28- Mayflower

2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
7.1	15.2	16.0	16.8	17.6	18.5	19.4	20.4	21.4	22.5	23.6	24.8	26.0	27.3	28.7	30.1	31.6	33.2	34.9	36.6
4.6922914	10.082086	10.58936	11.096635	11.66732	12.238	12.8721	13.50619	14.20369	14.9012	15.66211	16.42302	17.24734	18.13507	19.0228	19.97394	20.98849	22.00304	23.081	24.28578
3.6030095	7.7416014	8.131116	8.52063048	8.958834	9.397038	9.883931	10.37082	10.90641	11.44199	12.02626	12.61053	13.24349	13.92514	14.6068	15.33713	16.11616	16.89519	17.72291	18.64801
183.02423	393.25478	413.0412	432.827583	455.0873	477.347	502.08	526.813	554.0193	581.2256	610.9052	640.5848	672.7377	707.3639	741.9901	779.0896	818.6625	858.2353	900.2814	947.2741
6054.8561	13009.758	13664.34	14318.9164	15055.32	15791.72	16609.94	17428.17	18328.21	19228.26	20210.13	21192	22255.69	23401.2	24546.71	25774.05	27083.21	28392.37	29783.35	31337.97

Existing Bus Service Air Quality Analysis Worksheet for Net New Riders

(based on SRPEDD methodolgy for calcuations)

FILL IN SHADED BOXES ONLY

Route: Liberty Link

Summary of Vehicle Emission Rates:

Emission Rates by Vehicle Type	Milestone Year for Rates	Oper. Speed (mph)	Summer VOC (grams/mile)	Summer NOx (grams/mile)	Winter CO (grams/mile)	Summer CO2 (grams/mile)
Auto	2016	20	0.280	0.215	11.340	368.1
Bus*	2016	18	0.231	1.016	0.46	997.9
HDDV 4	Vehicle type used for Bus emission factors (For example, HDGV 6 or HDDV 2b)					

*Please refer to the 'Emission Factors' tab to determine the most appropriate 'Bus' factors based on fuel type and gross vehicle weight. If you require 'Bus' factors for an operating speed other than 18MPH, or for 'Auto' factors other than 20 MPH, please contact Ethan Britland at 857-368-8840 or at Ethan.Britland@state.ma.us

Calculate VMT and emissions savings from private vehicles:

Convert daily bus ridership into private auto VMT savings:

Daily one way person trips (reduced)	/ average veh. occupancy	= daily one-way auto trips	x avg. auto trip length (miles)	= daily savings auto VMT
43.9	1.06	41	4.25	176

Calculate emissions change from auto VMT savings:	Daily Auto VMT change (net)	X Emission factor (auto)	/ 1000g per kg	= change/day in kg
Pollutant				
Summer VOC	-176	0.280	1000	-0.049
Summer NOx	-176	0.215	1000	-0.038
Winter CO	-176	11.340	1000	-1.996
Summer CO2	-176	368.100	1000	-64.791

Calculate bus route mileage and emissions per day:						
Pollutant	Total Route distance (miles)	X # of round trips per day	= fleet miles per day	X Emission factor (bus)	/ 1000g per kg	= change/day in kg
Summer VOC	4.25	12	51	0.231	1000	0.000
Summer NOx	4.25	12	51	1.016	1000	0.000
Winter CO	4.25	12	51	0.460	1000	0.000
Summer CO2	4.25	12	120	997.900	1000	0.000

Add impact of bus emissions to emission savings from private vehicles

Pollutant	change/day auto (kg)	+ change/day bus or van (kg)	= change/day (NET) in kg
Summer VOC	-0.049	0.000	-0.049
Summer NOx	-0.038	0.000	-0.038
Winter CO	-1.996	0.000	-1.996
Summer CO2	-64.791	0.000	-64.791

Calculate net emissions change in kilograms per year (seasonally adjusted)

Pollutant	change/day (NET) in kg	X operating days per year	X seasonal adj factor	= change per year in kg
Summer VOC	-0.049	306	1.0188	-15.364
Summer NOx	-0.038	306	1.0188	-11.798
Winter CO	-1.996	306	0.9812	-599.294
Summer CO2	-64.791	306	1.0000	-19825.988

Calculate cost effectiveness (cost per kg of emissions reduced)

Pollutant	Total Project Cost	/ Project Life in years	/ reduction per year in kg	= annual cost per kg
Summer VOC			15.364	#DIV/0!
Summer NOx			11.798	#DIV/0!
Winter CO			599.294	#DIV/0!
Summer CO2			19825.988	#DIV/0!

29- Liberty

		10%		5%																	
2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038		
8.2	17.7	18.6	19.5	20.5	21.5	22.6	23.8	24.9	26.2	27.5	28.9	30.3	31.8	33.4	35.1	36.8	38.7	40.6	42.7		
2.974886	6.404755	6.719743	7.03473134	7.384718	7.769703	8.154689	8.574673	8.994656	9.449639	9.904622	10.3946	10.91958	11.47956	12.03954	12.63452	13.26449	13.92947	14.62944	15.36441		
2.284288	4.917937	5.159803	5.40166871	5.670408	5.966022	6.261636	6.584124	6.906611	7.255973	7.605335	7.98157	8.38468	8.814663	9.244647	9.701504	10.18524	10.69584	11.23332	11.79767		
116.0363	249.8194	262.1056	274.391809	288.0431	303.0596	318.0761	334.4577	350.8393	368.586	386.3327	405.4446	425.9216	447.7637	469.6059	492.8131	517.3856	543.3231	570.6258	599.2936		
3838.745	8264.592	8671.047	9077.50227	9529.119	10025.9	10522.68	11064.62	11606.56	12193.66	12780.76	13413.03	14090.45	14813.04	15535.63	16303.37	17116.29	17974.36	18877.59	19825.99		

30- Net New Riders SSC)

Social Cost of Carbon and Net Non-Co2 Benefits

Year	Calendar Year	Non CO2	Non CO2	Net non CO2	7% NPV Non	3% NPV Non	CO2 Reduced	3% SCC	Undiscounted	NPV Co2	7% NPV	3% NPV		
		Benefits	Costs		Benefits	CO2 Benefits			CO2 Benefits	CO2 costs @ 3%	costs @ 3%	Total		Total
		(2013\$)	(2013\$)	Benefits	CO2 Benefits	CO2 Benefits	Metric Tons	(2013\$)	Avg SCC	Avg SCC	Benefits	Benefits		
	0	2014		0	0	0		44	0.00	0	0	0		
	1	2015		0	0	0		45	0.00	0	0	0		
	2	2016		0	0	0		46	0.00	0	0	0		
	3	2017		0	0	0		47	0.00	0	0	0		
	4	2018		\$ -	0	0	-	49	\$ -	0	0	0	\$ -	Total emissions value
	5	2019		\$ 83.90	59.81901337	51.6004064	\$ 13.86	51	\$ 706.81	609.6986	669.517613	661.299006		
	6	2020		\$ 180.63	120.3586018	100.798434	\$ 29.84	52	\$ 1,551.52	1299.3699	1419.72851	1400.16835		
	7	2021		\$ 189.71	118.1389337	96.0577641	\$ 31.34	52	\$ 1,629.51	1324.9371	1443.07607	1420.9949		
	8	2022		\$ 198.78	115.6945727	91.330364	\$ 32.84	54	\$ 1,773.17	1399.7555	1515.45007	1491.08586		
	9	2023		\$ 208.94	113.6484039	87.1020384	\$ 34.51	55	\$ 1,898.25	1454.8493	1568.49773	1541.95137		
	10	2024		\$ 219.62	111.64264	83.0726091	\$ 36.28	56	\$ 2,031.56	1511.6689	1623.31149	1594.74146		
	11	2025		\$ 230.56	109.5388592	79.1332025	\$ 38.09	57	\$ 2,170.89	1568.2965	1677.83532	1647.42966		
	12	2026		\$ 242.07	107.4826495	75.3861678	\$ 39.99	58	\$ 2,319.23	1626.6646	1734.14721	1702.05072		
	13	2027		\$ 254.34	105.5401811	71.8677277	\$ 42.01	60	\$ 2,520.76	1716.5137	1822.05392	1788.38147		
	14	2028		\$ 266.92	103.5152279	68.4357603	\$ 44.09	61	\$ 2,689.55	1778.1108	1881.62607	1846.5466		
	15	2029		\$ 280.26	101.5773612	65.1986429	\$ 46.29	62	\$ 2,870.24	1842.2982	1943.87553	1907.49682		
	16	2030		\$ 294.16	99.64083591	62.0928747	\$ 48.59	63	\$ 3,061.20	1907.6371	2007.27798	1969.73002		
	17	2031		\$ 308.85	97.77366975	59.1546782	\$ 51.02	63	\$ 3,214.10	1944.5848	2042.35843	2003.73943		
	18	2032		\$ 324.62	96.0420077	56.4145574	\$ 53.62	65	\$ 3,485.42	2047.3192	2143.36117	2103.73372		
	19	2033		\$ 340.63	94.18626505	53.7131109	\$ 56.27	66	\$ 3,713.61	2117.8199	2212.00618	2171.53303		
	20	2034		\$ 88.77	22.93948996	12.7010394	\$ 59.05	67	\$ 3,956.25	2190.4823	2213.42174	2203.18329		
	21	2035		\$ 373.09	90.1064605	48.4366626	\$ 61.63	68	\$ 4,190.80	2252.7628	2342.86926	2301.19946		
	22	2036		\$ 394.07	88.94612424	46.4203152	\$ 65.09	69	\$ 4,491.51	2344.0847	2433.0308	2390.50499		
	23	2037		\$ 413.58	87.24370122	44.2056635	\$ 68.32	71	\$ 4,850.56	2457.7413	2544.98496	2501.94692		
	24	2038		\$ 434.68	85.69561805	42.1565656	\$ 71.80	72	\$ 5,169.81	2543.2051	2628.90077	2585.36171		
Totals					1929.530617	1295.27858			58294.75	35937.8	37867.3308	37233.0788		

source:

TIGER BCA Resource Guide, updated 3/27/15